AN EVALUATION OF ARITHMETICAL COMPETENCE IN THE JUNIOR HIGH SCHOOLS OF LETHBRIDGE

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
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SYNOPSIS

This thesis, "An Evaluation of Arithmetical Competence in the Junior High Schools of Lethbridge," is the report of an effort to determine the present status of Arithmetic in the Junior High Schools of Lethbridge by testing grades seven, eight, and nine of that city. The Schorling Hundred Problem Arithmetic Test and the Intermediate California Arithmetic Test were administered to all the grades of the Junior High Schools. The results of the tests were studied with the object of finding areas of strength and weakness, the relative achievements of the three grade levels and whether the achievement of the Lethbridge students compared favorably with that of similar students elsewhere.

When the mean scores for the Hundred Problem Arithmetic Test were compared for significance of difference, it was found that the achievement of grade eight was superior to that of grade seven. There was no significant difference between the achievement of grade eight and nine. The achievement of all grades was well above that of the test norms.

An examination of the California test data showed that the rank order of achievement, high to low, was grade nine, grade eight, and grade seven. The achievement of all grades was above that of their grade level as shown by the norms. All of the grades obtained higher scores on Arithmetic Fundamentals than they did on Arithmetic Reasoning.

It was concluded that the area of strength for all grades was in fundamental operations and that areas of weakness were in arithmetic reasoning, together with problems dealing with decimals, fractions, and per cent.

Finally the conclusion became obvious that the California Arithmetic Test was a better measuring instrument, at these grade levels, than the Schorling Hundred Problem Arithmetic Test, since it reveals growth of arithmetical competence between grades eight and nine, an outcome which the Schorling test had failed to discover.

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CHAPTER I

THE PROBLEM

The needs of our children in the complex society of today necessitate a constant evaluation of all aspects of the educational program. Arithmetic is an integral part of our curriculum. The teaching of this subject aids in bringing about the objectives of education[1]- personal development, growth in family living, growth toward competence in citizenship, and occupational preparation. It is hardly necessary to point out the need for a knowledge and understanding of mathematics in the world of business. Most business activities require at least one of the following skills: accurate and rapid calculation, correct estimating, application of formulae, solving problems involving quantitative thinking, and interpreting graphs, charts, diagrams, and tables of figures.[2]

H.H. Remmers[3] defines evaluation as meaning "to ascertain the value or amount of; to appraise carefully." Measurement means "the act or process of ascertaining the extent, dimensions, and quality of something by comparison with a standard." We are evaluating arithmetical achievement when we determine the degree to which the pupils have moved toward the objectives or goals as

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[1] Junior High School Curriculum Guide for Mathematics, Department of Education, Province of Alberta, September 1952, p.3.

[2] Ibid., p. 2.

[3] H.H. Remmers and N.L. Gage, Educational Measurement And Evaluation. New York: Harper and Brothers, 1955, p. 617.

set out by the curriculum. When the attainment of the pupils is compared with the achievement of other standardized populations, measurement of their arithmetical achievement is taking place.

This study aims at measuring the levels of achievement in arithmetic reasoning and arithmetic fundamentals of grades seven, eight, and nine of the junior high schools of Lethbridge. Arithmetic reasoning will be measured through the pupils' understanding and skill in identifying number concepts, their use of symbols and rules, and their ability in solving equations and problems. Arithmetic fundamentals will be measured by the pupils' competence in addition, subtraction, multiplication, and division. Achievement will be further measured by comparing the level of accomplishment for each grade, and then comparing the achievement of the different grades. The arithmetic tests used in this study lend themselves to this purpose.

Another purpose of this study is to evaluate the adequacy of the arithmetic program, and to determine the level of achievement attained by the pupils of the junior high schools of Lethbridge. Analysis of the results of the tests employed will reveal the range of ability in the classes and provide a means for comparing achievement of grades seven, eight, and nine. The results will also bring out areas of strength and weakness. Some differences can be expected as outgrowths of variations in the instructional program and differences in the ability and background of the pupils.

CHAPTER II

EXPERIMENTAL DESIGN

In planning a sound experimental study due consideration must be given to problems of sampling, testing instruments, experimental procedures, analysis of data, and the interpretation of findings.

1. Source of Data

Various techniques have been devised for obtaining a sample which will be representative of its population. H.E. Garrett[4] states that the most trustworthy way of securing representativeness is to make sure that the sample is random. The next requirement is sample size. The larger the sample the more truly it mirrors the characteristics of the population or supply. In this study both of these considerations have been kept in mind in the effort to insure that a reliable and representative sample was chosen. The total population of junior high schools of Lethbridge was: grade seven 350, grade eight 340, and grade nine 280. As this was too large a group to work with, a random sample of approximately 150 was chosen from each grade. When the pupils had been numbered the sample was selected from the total population according to Fisher's[5] table of random numbers. Since it would have caused considerable inconvenience to the teachers of the Lethbridge junior high schools if the tests had been administered to only selected students, arrangements were made to test

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[4]H.E. Garrett, Statistics in Psychology and Education. New York: Longmans, Green and Co., 1953, p. 202.

[5]R.A. Fisher and F. Yates, Statistical Tables. New York: Hafner Publishing Company, 1948.

all the pupils in each class. This procedure permitted the tests to be given in a normal classroom atmosphere. The tests were scored according to the scoring keys supplied by the test-makers.

2. Testing Instruments

It was decided to use two tests to measure the arithmetical competence of the students of the junior high school. In this way it was hoped that a more thorough investigation could be carried out. The Hundred Problem Arithmetic Test, Form V, and the California Arithmetic Test, Intermediate, Form AA were used. These tests are described and evaluated in the next chapter.

3. Procedure

Frequency tables were compiled from the resulting scores for each of the five sub-sections and the total for the Hundred Problem Test, and for each of the eight sub-sections, and total score for the California Arithmetic Test. The mean and standard deviation for all total scores, and scores for sections and sub-sections of both tests were then computed.[6]

The significance of differences between the means of grade seven and grade eight, of grade seven and grade nine, and of grade eight and grade nine for each score was then computed in the following manner. The standard error of the mean was calculated using formula $\sigma_M = \frac{\sigma}{N}$ The standard error of the difference between two means was calculated using formula $\sigma_D = \sqrt{\sigma_{M_1}^2 + \sigma_{M_2}^2}$

The critical ratio was obtained by dividing the difference of

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[6]Garrett, op. cit., pp. 33-53.

the two means by the standard error of the difference. C.R. = $\frac{D}{\sigma_D}$ The critical ratio was tested against the t-table. The null hypothesis was rejected at the .05 and .01 levels of confidence.[7] A comparison of the achievement of grade seven, grade eight, and grade nine with the test norms was then completed.

As a result of this study it was hoped that dependable answers might be found for the following questions:

1. What is the level of arithmetic achievement of the boys and girls in grades seven, eight, and nine, in the junior high schools of Lethbridge?

2. What are their strengths and weaknesses in arithmetic in each of the grades?

3. How does the achievement of grade seven compare with that of grade eight, and of grade eight with that of grade nine?

4. How well does the achievement of grade seven, eight, and nine, compare with that of established test norms?

5. How efficient are the Hundred Problem Arithmetic Test and the California Arithmetic Test in the measurement of competence in arithmetic?

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[7]Garrett, op. cit., pp. 187-189.

CHAPTER III

THE TESTING INSTRUMENTS

An evaluation of the testing instruments used in this study will be presented in this chapter. They were the California Arithmetic Test, Intermediate, Form AA, for grades seven, eight, and nine,[8] and the Hundred Problem Arithmetic Test, Form V.[9] These will be referred to in the following pages as "The California Test" and "The Hundred Problem Test," respectively.

1. The Hundred Problem Test

There are two forms of this test, Form V and Form W. The one hundred items of each are arranged in five sections: addition-ten items, subtraction-ten items, multiplication-fifteen items, division-fifteen items, and fractions, decimals, and per cent-fifty items. This test is recommended for use in grades seven to twelve inclusive. It is easy to administer requiring a total of forty minutes. The authors claim that it not only measures numerical facility, but is so constructed that it minimizes extraneous factors such as verbal ability, and gives a practical measure of the computational skills.

The correlation between scores on the Hundred Problem Test,

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[8] Intermediate California Arithmetic Test, Form AA. Los Angeles: California Test Bureau, 1950.

[9] Hundred Problem Arithmetic Test, Form V. Yonkers-on-Hudson: World Book Company, 1938.

Form V, and the Terman-McNemar Test of Mental Ability Form C, was .43 for two hundred seventy-eight pupils in grade ten, while the correlation of the Hundred Problem Arithmetic Test and the Foust-Schorling Test of Functional Thinking in Mathematics was .53 for all grade ten pupils in the national standardization population. Reliability coefficients of .94 and .95 were established by the Kuder-Richardson[10] formula, which indicate that a high degree of consistency may be expected in measuring arithmetical skills.

W.J. Osburn[11] states:

> It not only measures skills with whole numbers but it involves the various steps by which skills are built up in the less frequently measured subjects of common fractions, decimals, percentage, and denominate numbers.
> It is encouraging to find authors who have courage to resist the presentation of the addition and subtraction of decimals without a common denominator. Here is at least one attempt to break the vicious circle which exists when standard tests are validated in terms of textbooks containing useless material which violates social usuage. Two forms of the test are matched item by item with unusual care. In the first four parts the exercises are arranged according to process in order to facilitate diagnosis. Norms are given for each division separately. Reliability coefficients range from .85 to .91. Provisions for validity are adequate. The chief defect of the test is the failure to provide age norms and some T-score technique. After all, however, the faults of the test are relatively minor and the reviewer recommends its use.

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[10] C.F. Kuder and M.W. Richardson, "The Theory of the Estimation of Test Reliability," Psychometrika, Vol. 2, No. 3, September, 1937, pp. 151-160.

O.K. Buros, (Ed.), The Third Mental Measurements Yearbook. New Brunswick, New Jersey: Rutgers University Press, 1940, p. 1462.

2. The California Test

The Intermediate California Arithmetic Test is suitable for grades seven, eight, and nine. Because of the wide range of ability found in most grades, this test provides for measurement several grades above and below the particular grade being tested. The California Arithmetic Test is one of a group of three tests which comprise the Intermediate Battery of the California Achievement Test series. The Arithmetic test may be used, alone, or in conjunction with the corresponding forms of the Reading and Language Test, when a more comprehensive coverage of basic skills is desired. All levels and forms of the California Test series possess a high degree of validity. The coefficients of reliability are given for the two main parts of the test and for the total. The reliability for Arithmetic Reasoning is .92 with a standard error of measurement of .41. For Arithmetic Fundamentals the reliability coefficient is .95, with a standard error of measurement of .32. The reliability for the entire test is .95 with a standard error of measurement of .33. These coefficients were determined by averaging the intercorrelations of the different forms of the test for a single grade range.

The total working time of seventy-four minutes may be broken conveniently into two sessions. The Examiner's Manual[12] gives clear and adequate directions for the administration of the test. The test may be hand or machine scored.

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[12] E.W. Tiegs and W.W. Clarke, Manual California Arithmetic Test. Los Angeles: California Test Bureau, 1950.

The California Arithmetic Test is designed not only to measure achievement, but to provide a basis for planning remedial instruction in the areas where individuals may be deficient. The test is divided into two parts, reasoning and fundamentals. When the test has been corrected and the scores tabulated on the last page, a graph may be completed indicating grade location and percentile rank. Both reasoning and fundamentals are analyzed into parts and each part is keyed to the problem or example which illustrates it. For example, addition is analyzed into the following: 1. simple combinations, 2. bridging, 3. carrying, 4. zeros, 5. column addition, 6. adding money, 7. adding numerators, 8. common denominators, 9. mixed numbers, 10. fractions and decimals, 11. writing decimals, 12. adding percentages, and 13. denominate numbers.[13] The experts discount the value of the test as a diagnostic instrument but seem to agree that it has value for survey purposes.

Some of the comments of the reviewers are:

> The California Arithmetic Tests were designed to serve as diagnostic instruments. Owing to the small numbers of items in each type and the consequent low reliability of partial scores, however, it was concluded that these tests are better suited for survey purposes.[14]
> The California Arithmetic Test, with four carefully equated forms at each of three levels, provides a good instrument

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[13] A.M. Jordan, Measurements in Mathematics. New York: McGraw Hill Book Company, Inc., 1953, p. 231.

[14] Anora Anastasi, Psychological Testing. New York: MacMillan Co., 1954, p. 483.

> for surveying performance in fundamental operations, problem solving, and certain aspects of information. The tests are easily administered and scored, and the comparison of individual scores with norms can be done in a minimum of time. The diagnostic features of the test are not so valuable as they seem, but they have some value for teachers aware of diagnostic limitations of tests that survey widely.[15]
>
> Each test consists of two parts, Arithmetic Reasoning and Arithmetic Fundamentals, each of which is sub-divided into three to five sections. The sections of the "reasoning" test deal in each case with the recognition of numerals, symbols, rules, the written expression of quantities, and problem-solving. The sections of the "fundamental" test deals in each case with the four operations on progressively higher levels of difficulty.
>
> The section of each "reasoning" test other than the one in problem-solving, are tests of the pupil's knowledge, not of his ability to reason or to recognize ideas of combination in practical situations. The tests are intended to be useful both for survey and diagnostic purposes.[16]
>
> The authors of this test have tried to provide simple situations which reveal the presence or absence of essential functional ability rather than to include long and involved problems in the solution of which differences in attention span and memory may operate as disturbing factors.[17]

In view of the strong assets and few limitations of the California Test as brought forth by the reviewers, it may be stated that the California Test constitutes a good instrument for surveying performance in fundamental operation. The diagnostic features of the test are to be discounted, however, as they are based upon too few items. The tests can be administered and scored in a minimum of time making it a practical measuring instrument.

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[15] O.K. Buros, (Ed.), The Fourth Mental Measurements Yearbook. p. 411.

[16] O.K. Buros, (Ed.), The Nineteen Forty Mental Measurements Yearbook. p. 1459.

[17] Tiegs and Clarke, op. cit.

CHAPTER IV

RELATED STUDIES

This chapter records the results of a search of educational literature relating to the subject of this thesis. Special attention was given to articles which reported on the continuum of arithmetical achievement through the grades.

Clemens and Neubauer[18] studied difficulties in multiplication encountered by 2000 children in grades four to eight; they found that all possible types of errors were made.

In 1936 Harvey[19] tried to ascertain what progress in mathematics was being made by pupils from grade seven to grade eleven in the Alberta school system. From his study, he concluded:

1. Pupils are deficient in ability to perceive and apply such relationships as those involved in direct and inverse proportion.

2. Pupils show little improvement, between grades seven to eleven, in ability to handle problems involving functional dependence. In general pupils can do what they have been taught to do.

In 1943 Arthur[20] prepared a test to see which of the requirements advanced by the committee on Essential Mathematics for Minimum

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[18] R.B. Clemens and P.F. Neubauer, A Supervision Project in Multiplication. Journal Educational Research, 18: 387-96, 1928.

[19] J.E. Harvey, The Growth of Mathematical Abilities in Grades Seven to Eleven of the Secondary School. Master Thesis. 1936. Not Published.

[20] L.E. Arthur, "Diagnosis of Desirabilities in Arithmetic Essentials," The Mathematics Teacher, 43: 197-202, May 1950.

Army Needs required further attention in high school. He found that freshman entering high school three or four years after the publication of the report did not have adequate understanding of or the ability to work many of the problems considered essential. Much specificity in learning was revealed by the test. Important difficulties with decimals and per cent were found. Arthur concluded that remedial teaching at the high school level is necessary to meet the essentials listed by the committee.

A study of Montgomery[21] supplements nicely the findings of Arthur. Montgomery investigated the ability of the seventh grade pupils to use per cent, decimals, and fractions interchangeably and with understanding. The scope of the problems were confined to case II relationships,[22] which involve finding the ratio of one number to another. A special test was designed to measure the degree of understanding as well as facility in abstract computation. The tests were given to 624 pupils in grade seven. The results showed that children could not use quantities expressed in decimals, fractions, or per cent with equal facility. Comparisons yielding values greater than one or 100% were especially troublesome. When the population was divided into higher, middle, and lower thirds, it was found that the higher third could use all three forms with more facility than either of the other two groups, and that the common fraction form was much preferred by pupils in the lowest

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[21] J.F. Montgomery, An Investigation of Case II Relationship in Arithmetic, Doctor's Thesis, Durham, N.C. Duke University, 1950, p. 177.

[22] L.J. Brueckner and F.E. Grossnickle, Making Arithmetic Meaningful. Philadelphia: The John C. Winston Company, 1953, p. 396.

third. Montgomery pointed out the need for reducing specificity in learning by a more meaningful approach to the interrelationships between decimals, fractions and per cent. He suggested much more attention needs to be given to fractions and ratios. He also pointed out the inadequacy of current testing instruments for measuring these interrelationships.

Sueltz and Benedick[23] called attention to the fact that the capacity to use arithmetic functionally means more than ability to compute. They constructed tests to measure understandings and judgements as well as computation and problem solving. The results from 2000 sixth grade students in three eastern states revealed glaring weaknesses in all areas measured: understanding, judgement, computation, and problem solving. The tests were repeated in grade nine and in the senior high school with approximately the same conclusions.

The authors found that competence in functional arithmetic falls once the grade six level has been passed. Furthermore, the program of mathematics at the junior and senior high school levels was not adequate to overcome the shortcomings and deficiencies revealed by the tests in grade six.

Glennon[24] reported pioneer research with an instrument for

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[23] B.A. Sueltz and J.W. Benedick, "The Need for Extending Arithmetic Learnings," The Mathematics Teacher, 43: 69-73, February 1950.

[24] V.J. Glennon, "Testing Meanings in Arithmetic," Supplementary Educational Monographs, No. 70, Chicago: University of Chicago Press, 1949.

measuring growth in understanding and meaning in arithmetic. He constructed a multiple choice test of eighty items covering five areas of meaning and understanding basic to computational processes taught in grades one to six. The test was validated in part on the basis of combined judgements of sixteen experts in subject matter, and in part by observation of its ability to distinguish between pupils who understood the meanings and those who did not. The test was administered to 1139 subjects at seven levels: grade seven, grade eight, grade nine, grade eleven, grade twelve, college freshmen, and college seniors. No significant difference in achievement of basic mathematical understandings between grade seven and grade eight was found. Grade nine was found to be significantly superior to grade eight. One may question the educational significance of this difference without challenging the statistical conclusion. The mean score in per cent of items correct was 14.01 for grade eight and 18.02 for grade nine. In an eighty item test the difference in means would amount to 3.2 items which is hardly an educational accomplishment of a magnitude to justify an additional year of work.

R.O. Pritchard[25] in his province-wide survey of arithmetical achievement in grade five, found that while the Alberta medians did not differ from Iowa medians, the medians of the Alberta rural ungraded school sample were significantly inferior to those of the Iowa standardization sample in all sections of the test.

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[25] R.O. Pritchard, A Survey of the Arithmetical Achievement of Grade Five Pupils in Alberta Schools, Master's Thesis, Unpublished, University of Alberta, Edmonton, 1955.

In his survey of arithmetical achievement of grade eight pupils in Alberta C.E. Climenhaga[26] found that the town and urban children compared favorably, in most areas tested, with the standardization group of the Iowa Every Pupil Test of Basic Arithmetical Skills, but the poor attainment of the ungraded rural pupils persisted at this level.

These investigations reveal many shortcomings of the pupils' achievement. Glaring weaknesses in the four fundamental operations are common in the intermediate, junior high, and senior high schools. Important difficulties with decimals and per cent are found. Pupils are very deficient in ability to perceive and apply such relationships as those involved in direct and inverse proportion. To eliminate those shortcomings remedial teaching is necessary at the high school level. It is also recommended that more attention be given to the study of fractions and ratios.

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[26]C.E. Climenhaga, A Survey of Arithmetical Achievement of Grade Eight Pupils in Alberta Schools, M.Ed. Thesis, University of Alberta, 1955.

CHAPTER V

THE SCHORLING HUNDRED PROBLEM DATA

In this chapter the results of the administration of The Hundred Problem Arithmetic Test will be presented. Tables and frequency polygons will present graphically the statistics derived from the raw data, and the achievement of grades seven, eight and nine on the five sections of the test will be compared.

1. Achievement in Addition

There were ten problems in addition of various types: single column addition, ragged decimal addition, addition of fractions with related denominators, addition of two mixed numbers with fractions of related denominators, addition of three mixed numbers with related denominators, and addition of decimal fractions. The achievement of each grade on the ten problems is given in Table I.

TABLE I

DISTRIBUTION OF GRADE SEVEN, EIGHT, AND NINE SCORES, HUNDRED PROBLEM ARITHMETIC TEST, PART I, ADDITION

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
10	25	48	42
9	49	45	45
8	28	29	30
7	31	23	16
6	9	12	7
5	10	5	2
4	5	1	2
3	2	1	0
2	1	0	0
1	1	0	0
Totals	161	164	144

These data are represented graphically in Figure 1.

TABLE II

MEAN SCORES FOR GRADE SEVEN, EIGHT, AND NINE ON PART I, ADDITION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Mean	Standard Deviation	Standard Error of Mean
Grade Seven	7.856	2.79	.220
Grade Eight	8.427	1.49	.116
Grade Nine	8.59	1.33	.110

Grade nine obtained the highest mean score, followed by grade eight, and then grade seven. The reverse order prevailed in the standard deviations, with the greatest variability occurring in grade seven.

The differences between the means of the three samples were tested for significance against Fisher's table of t. The comparisons appear in Table III.

Examination of the table reveals highly significant mean differences. This must be interpreted as meaning that such differences are real, being too great to be the result of accidents of sampling. The critical ratio of the difference between grade seven and eight is significant at .05 level, while the critical ratio of the difference between grade seven and nine is highly significant at .01 level. There is no significant difference in achievement in addition between grades eight and nine.

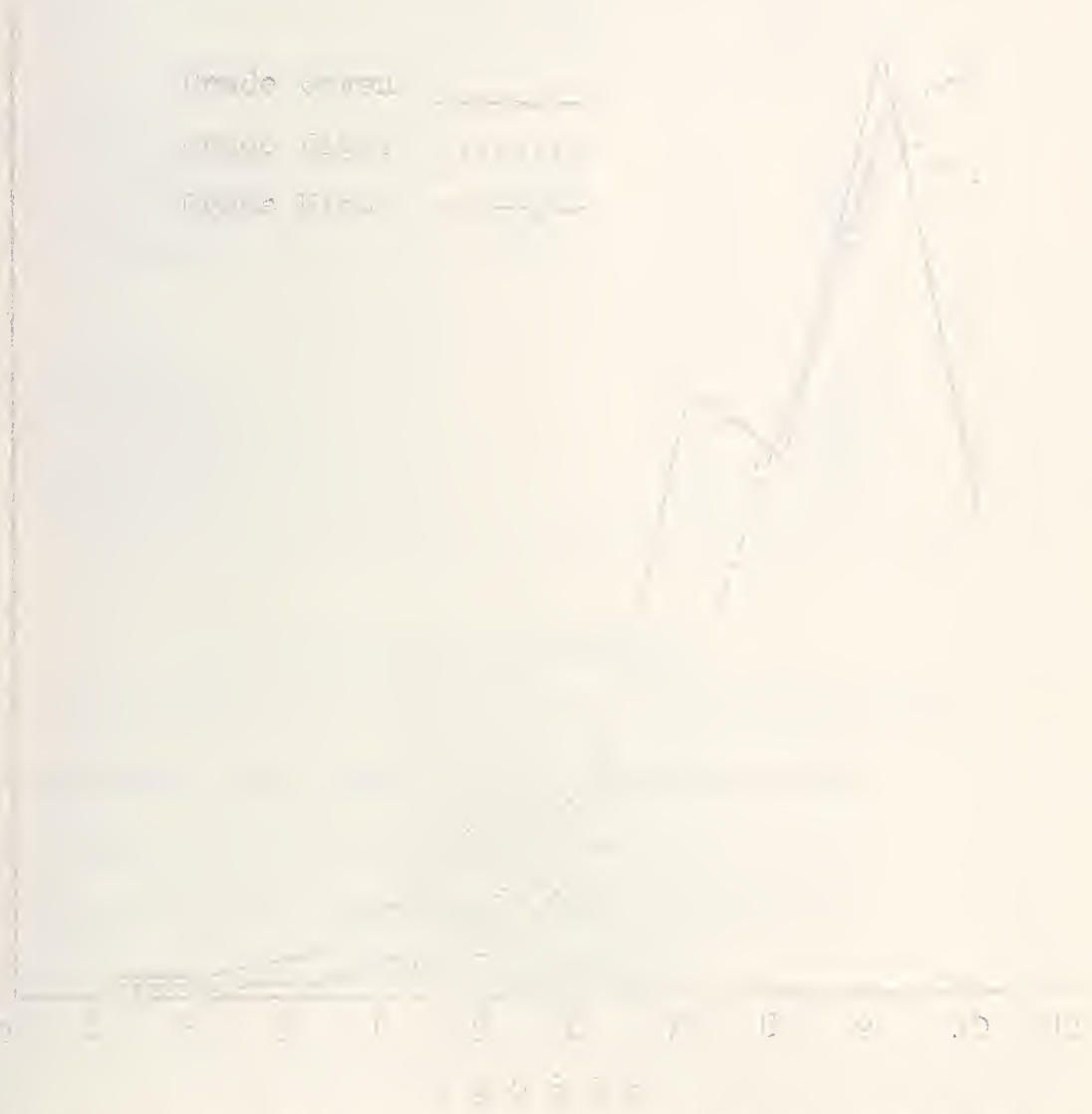


Fig. 1 Distribution of [illegible] Eighth and Ninth Grades, Hundred Possible Arithmetic Test, Part I, Addition

TABLE III

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON PART I, ADDITION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean differences.....	.571	.734
SE of difference.....	.248	.246
Critical ratio.....	2.30	2.98
Significance.....	.05	.01
Grade Eight		
Mean difference.....		.163
SE of difference.....		.159
Critical ratio.....		1.02
Significance.....		.....

2, Achievement in Subtraction

In this section of the test there were ten problems dealing with subtraction. They dealt with the subtraction of four figure numbers, subtraction of decimals and subtraction of fractions with related denominators. Table IV gives the frequencies of scores obtained in subtraction.

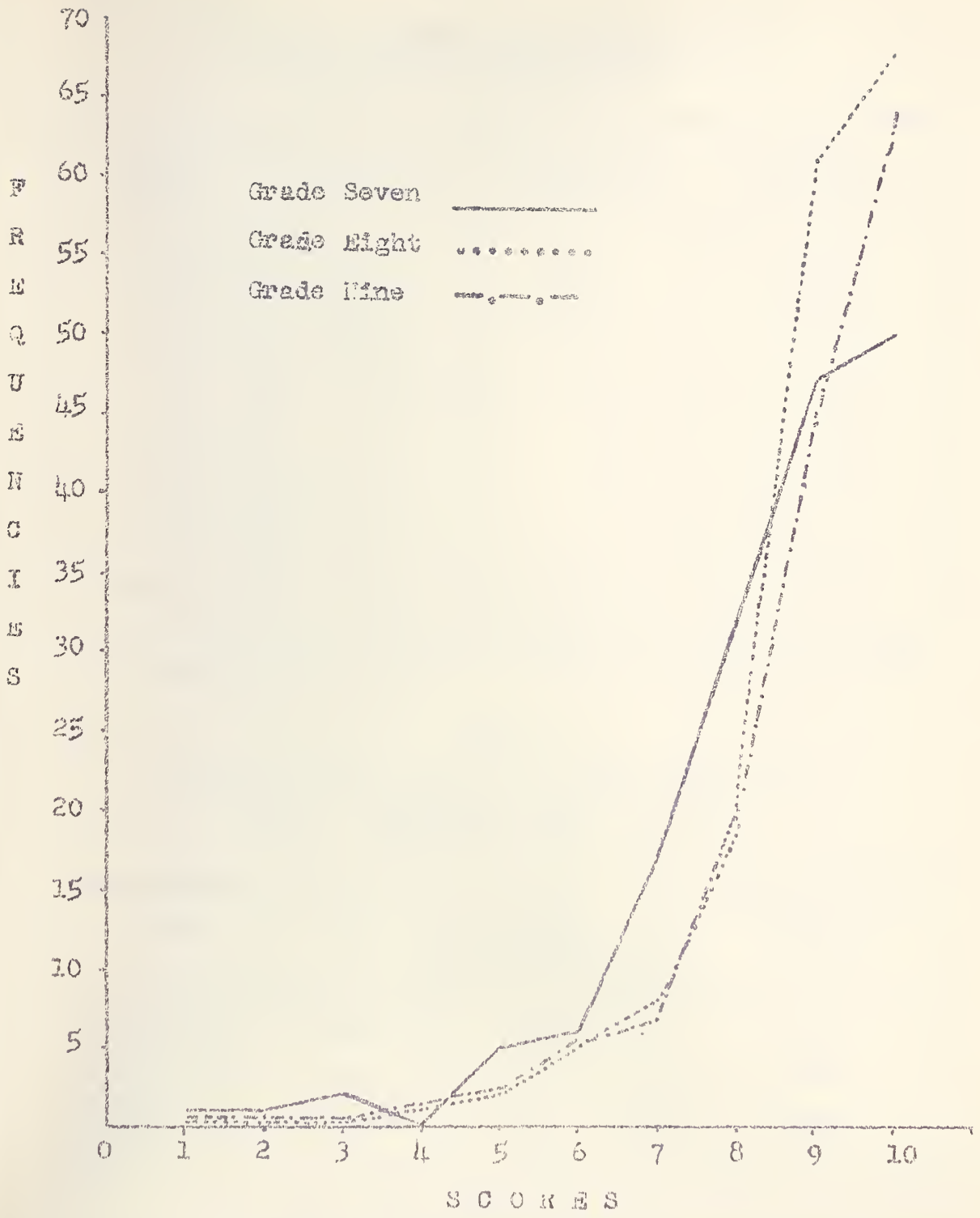


Fig. 2. Distribution of Grade Seven, Eight, and Nine Scores, Hundred Problem Arithmetic Test, Part II, Subtraction.

TABLE IV

DISTRIBUTION OF GRADE SEVEN, EIGHT, AND NINE SCORES, HUNDRED PROBLEM ARITHMETIC TEST, PART II, SUBTRACTION

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
10	50	68	64
9	47	61	45
8	32	19	20
7	17	8	7
6	6	5	5
5	5	2	2
4	0	1	1
3	2	0	0
2	1	0	0
1	1	0	0
Totals	160	164	144

These data are illustrated in Figure 2 on the preceding page.

TABLE V

MEAN SCORES FOR GRADE SEVEN, EIGHT, AND NINE ON PART II, SUBTRACTION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Mean	Standard Deviation	Standard Error of Mean
Grade Seven	8.54	2.18	.172
Grade Eight	9.03	1.16	.091
Grade Nine	9.01	1.21	.108

The grade eight group obtained the highest mean score followed by grade nine, and then grade seven. The grade seven group had the largest standard deviation, followed by grade nine and then grade eight. The grade eight group had a higher mean score than the grade nine, but the difference is not significant.

TABLE VI

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE, ON PART II, SUBTRACTION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean differences.....	.587	.471
SE of difference.....	.194	.203
Critical ratio.....	3.02	2.31
Significance.....	.01	.05
Grade Eight		
Mean difference.....		.016
SE of difference.....		.140
Critical ratio.....		.115
Significance.....		....

The table may be interpreted as follows: (1) there is a significant difference between the achievement of grade seven and grade eight in subtraction; (2) the achievement of the grade nine in subtraction is superior to that of grade seven; (3) there is no significant difference between the achievement of grade eight and nine in subtraction.

3. Achievement in Multiplication

Fifteen various types of multiplication problems make up Part III of the Hundred Problem Test. There are problems with two figure multipliers, three figure multipliers, problems in taking a fractional part of a number, multiplying a mixed number by a fraction, and multiplying a decimal by a decimal.

TABLE VII

SCORES OBTAINED BY PUPILS ON PART III, MULTIPLICATION, HUNDRED PROBLEM ARITHMETIC TEST

Problems Correct	Grade Seven	Grade Eight	Grade Nine
15	9	22	28
14	30	38	39
13	25	34	28
12	37	29	23
11	17	19	11
10	11	10	4
9	17	4	3
8	10	3	3
7	7	2	2
6	5	2	2
5	4	0	1
4	1	0	0
3	0	1	0
2	1	0	0
1	0	0	0
Totals	164	164	144

These data are illustrated in Figure 3 on the following page. Table VIII below gives the mean scores and standard deviations obtained by grades seven, eight, and nine.

TABLE VIII

MEAN SCORES OBTAINED BY PUPILS ON PART III, MULTIPLICATION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Mean	Standard Deviation	Standard Error of Mean
Grade Seven	11.396	2.64	.206
Grade Eight	12.50	1.91	.149
Grade Nine	12.84	2.05	.171

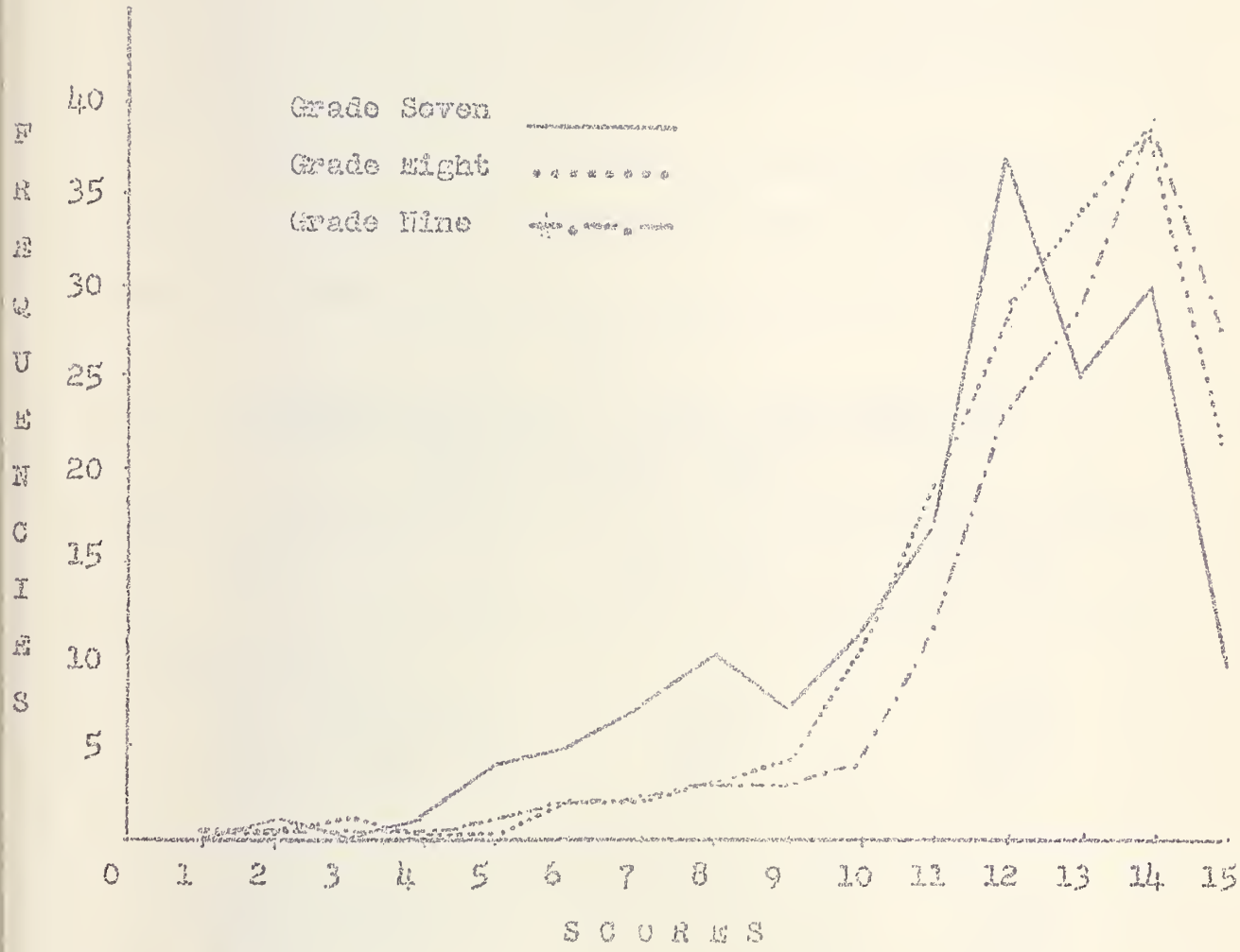


Fig. 3. Distribution of Grade Seven, Eight, and Nine Scores, Hundred Problem Arithmetic Test, Part III, Multiplication.

The grade nine obtained a slightly higher mean score than the grade eight which was followed by the grade seven. The standard deviation is greatest in grade seven indicating that the greatest degree of variation from the mean exists in this sample. There is indication that the degree of variability of scores is greater in grade nine than in grade eight.

The difference between the means of the three samples were tested for significance against Fisher's table of t. The comparisons appear Table IX.

TABLE IX

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE, ON PART III, MULTIPLICATION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean differences.....	1.104	1.444
SE of difference.....	.254	.267
Critical ratio.....	4.34	5.40
Significance.....	.01	.01
Grade Eight		
Mean difference.....		.34
SE of difference.....		.226
Critical ratio.....		1.46
Significance.....		.....

The study of Table IX reveals that the critical ratios indicate highly significant mean differences between grades seven and eight, and grades seven and nine. This indicates the superiority of both grade eight and nine over grade seven in multiplication. There is no significant difference between the achievement of grade eight and nine.

4. Achievement in Division

This section of the test is made up of various types of division problems. There are problems with single digit divisors, two digit divisors, and decimal divisors. There are problems involving division of fractions by fractions, and dividing mixed numbers by fractions. The achievement of the various samples is shown in Table X.

TABLE X

DISTRIBUTION OF GRADE SEVEN, EIGHT, AND NINE SCORES, HUNDRED PROBLEM ARITHMETIC TEST, PART IV, DIVISION

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
15	12	24	30
14	21	35	33
13	16	20	25
12	19	25	16
11	20	20	14
10	13	11	6
9	22	11	7
8	13	5	4
7	8	9	5
6	10	0	1
5	2	1	3
4	3	0	0
3	2	2	0
2	2	0	0
1	0	0	0
Totals	163	163	144

These data are further illustrated in Figure 4 on the following page. Table XI gives the mean scores and standard deviations obtained by the various groups.

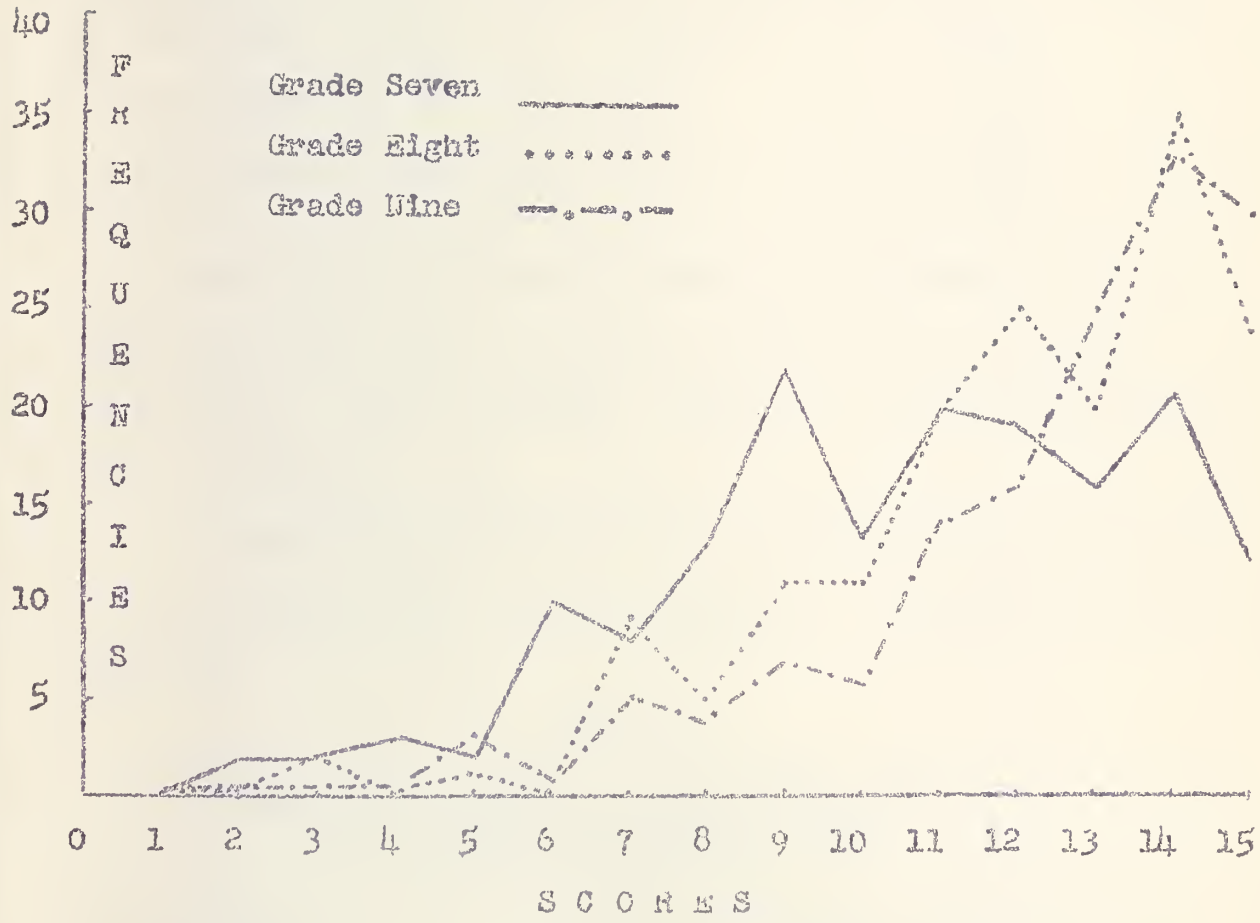


Fig. 4. Distribution of Grade Seven, Eight, and Nine Scores, Hundred Problem Arithmetic Test, Part IV, Division.

TABLE XI

MEAN SCORES FOR GRADE SEVEN, EIGHT, AND NINE ON PART IV, DIVISION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Mean	Standard Deviation	Standard Error of Mean
Grade Seven	10.49	3.06	.239
Grade Eight	11.98	2.54	.199
Grade Nine	12.46	2.45	.241

Grade nine obtained the highest mean score followed by the grade eight then grade seven. The standard deviation is the greatest in grade seven. There is a greater variability of scores in grade eight than in grade nine.

The differences between the means of the three samples were tested for significance against Fisher's table of t. The comparisons appear in Table XII.

TABLE XII

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE, ON PART IV, DIVISION, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean differences.....	1.49	1.97
SE of difference.....	.311	.339
Critical ratio.....	4.79	5.80
Significance.....	.01	.01
Grade Eight		
Mean difference.....		.478
SE of difference.....		.312
Critical ratio.....		1.53
Significance.....		.....

There is a significant difference between the achievement of grade seven and grade eight at the .01 level of confidence. There is a similar difference between the achievement of grade seven and grade nine. There is no difference in achievement between grade eight and grade nine.

5. Achievement in Fractions, Decimals, and Per Cent

In this section of the Hundred Problem Test there are fifty problems dealing with fractions, decimals, and per cent. There are problems of converting common and decimal fractions into per cent, converting common fractions and per cents into decimals, and expressing per cents as common fractions. There are per cent problems of the three types: (a) taking a per cent of a number, (b) one number is what per cent of another number? (c) what per cent of one number equals another number? There are problems in arranging decimal fractions in ascending and descending orders of magnitude. The concluding problems of the test are general questions dealing with the application of per cent in practical situations involving types a, b, and c mentioned above. Table XIII gives the distribution of the scores obtained on this section. These data are further illustrated in Figure 5.

TABLE XIII

SCORES OBTAINED ON PART V, FRACTIONS, DECIMALS AND PER CENT, HUNDRED PROBLEM ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
50	0	0	1
49	0	1	2
48	0	3	1
47	0	5	4
46	1	4	1
45	0	3	6
44	1	3	8
43	0	7	4
42	2	10	4
41	3	6	3
40	3	8	5
39	5	9	8
38	7	8	8
37	6	6	11
36	8	8	7
35	8	11	7
34	10	8	8
33	6	7	4
32	7	10	5
31	8	8	5
30	10	4	7
29	14	6	5
28	10	0	2
27	7	4	4
26	5	3	5
25	6	3	7
24	1	4	1
23	3	1	2
22	5	2	0
21	7	0	0
20	5	3	2
19	3	3	0
18	2	1	1
17	2	1	0
16	1	0	1
15	1	0	1
14	1	0	0
13	2	1	0
12	1	0	1
11	1	2	0
10	0	0	1
9	1	0	0
8	0	0	0
7	0	0	0
6	0	0	0
5	0	0	1
Totals	163	163	144

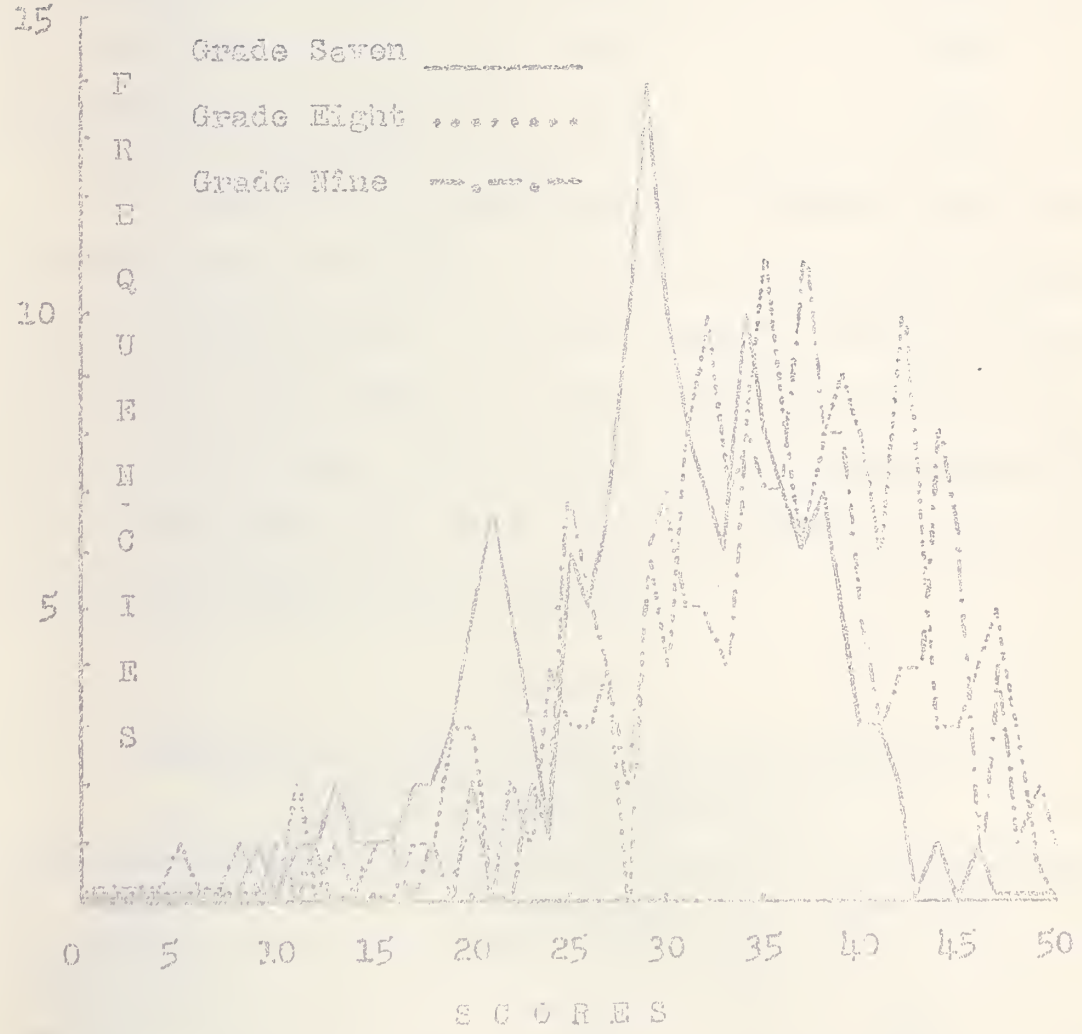


Fig. 5. Distribution of Grades Seven, Eight, and Nine Scores, Hundred Problem Arithmetic Test, Part V, Fractions, Decimals, and Per Cents.

TABLE XIV

MEAN SCORES FOR GRADE SEVEN, EIGHT, AND NINE IN THE USE OF FRACTIONS, DECIMALS, AND PER CENT, PART V, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Mean	Standard Deviation	Standard Error of Mean
Grade Seven	29.53	6.94	.543
Grade Eight	34.92	7.46	.584
Grade Nine	34.52	8.45	.704

Grade eight has the highest mean score followed by grade nine and grade seven in that order. Grade nine has the largest standard deviation indicating that the greatest degree of variation from the mean exists in this sample. The grade seven sample has the least variability of scores. Table XV gives the comparison of the difference between means of the various samples together with the tests for significance against Fisher's table of t.

TABLE XV

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE IN FRACTIONS, DECIMALS AND PER CENT, PART V, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean differences.....	5.393	5.00
SE of difference.....	.797	.889
Critical ratio.....	6.76	5.62
Significance.....	.01	.01
Grade Eight		
Mean difference.....		.40
SE of difference.....		.914
Critical ratio.....		.437
Significance.....		....

Examination of Table XV reveals that the critical ratios indicate highly significant mean differences between grade seven and grade eight, and between grade seven and grade nine. The conclusion must be accepted that there is a real difference between the achievement of grade seven and eight, and grade seven and grade nine in Part V of the test. There is no difference between the achievement of grade eight and grade nine.

6. Achievement of Grades Seven, Eight, and Nine on the Total Test

The total test is made up of one hundred problems in addition, subtraction, multiplication, division, fractions, decimals and per cent. In considering the achievement of the various grades in the above subsections it was found that there was a significant difference between grade seven and grade eight in all cases, but there was no significant difference between grade eight and grade nine. These findings make it possible to state, with some degree of confidence, that achievement in arithmetic in grade eight is superior to that of grade seven. However, there is no significant difference in achievement between grades eight and nine, at least insofar as the scores on the Hundred Problem test are concerned. The total scores bear out the same findings as the subscores. The scores on the total test are given in Table XVI.

TABLE XVI

SCORES OBTAINED ON TOTAL TEST, HUNDRED PROBLEM ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
95-99	1	6	4
90-94	0	15	16
85-89	4	27	21
80-84	26	28	30
75-79	21	28	28
70-74	27	23	11
65-69	23	8	13
60-64	23	12	8
55-59	14	6	6
50-54	8	5	3
45-49	7	3	2
40-44	4	0	0
35-39	3	1	0
30-34	0	1	2
25-29	0	0	0
20-24	1	0	0
Totals	162	163	144

These data are further illustrated in the frequency polygon Figure 6, on the following page.

TABLE XVII

MEAN SCORES FOR GRADE SEVEN, EIGHT, AND NINE ON THE TOTAL TEST, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Mean	Standard Deviation	Standard Error of Mean
Grade Seven	67.75	12.75	1.001
Grade Eight	76.77	12.40	.971
Grade Nine	77.07	12.25	1.02

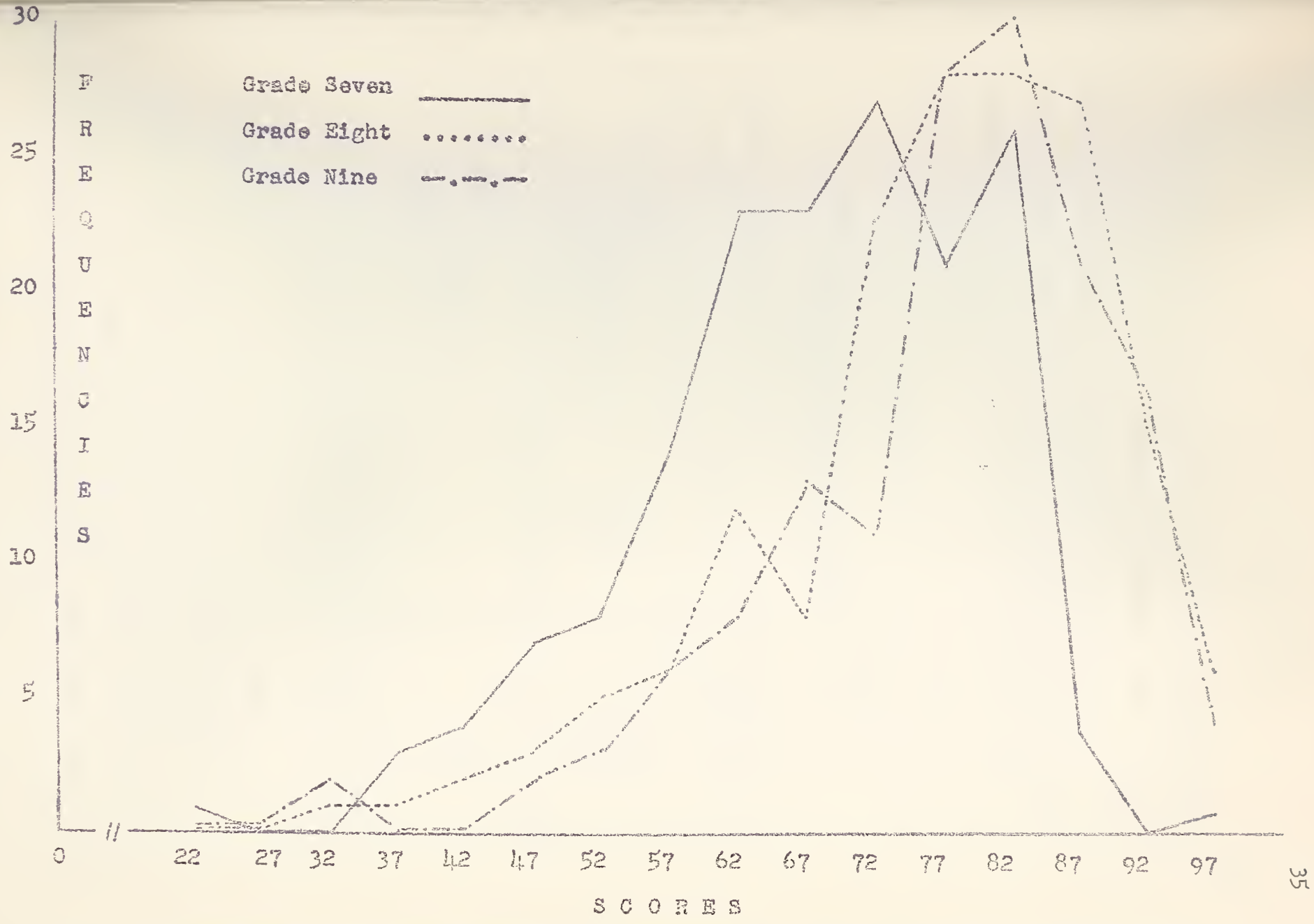


Fig. 6. Frequencies of Scores Obtained on Total Test, Hundred Problem Arithmetic Test.

Table XVII reveals that the grade nines have the highest mean score followed by grade eight, and then the grade sevens. The grade sevens have the highest standard deviation followed by the grade eights, then the grade nines. This is opposite to the order of the mean scores. The comparison of the achievement of these grades appears in Table XVIII.

TABLE XVIII

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON TOTAL TEST, HUNDRED PROBLEM ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean differences.....	9.19	9.49
SE of difference.....	1.394	1.429
Critical ratio.....	6.58	6.63
Significance.....	.01	.01
Grade Eight		
Mean difference.....		.298
SE of difference.....		1.408
Critical ratio.....		.21
Significance.....		.....

Table XVIII reveals significant differences between the achievements of grades seven and eight, but there is no significant difference between that of grade eight and nine. A possible reason for this might be that more attention is given in the grade eight arithmetic program to problems dealing with fundamental operations, and fractions, decimals and per cent, than is given in the grade nine program. Furthermore, time may have permitted the grade nine pupils to lose some of their ability

through disuse. Still another explanation is that the test does not discriminate effectively at this level.

7. Conclusions

Analysis of data obtained from the Schorling Hundred Problem Arithmetic Test leads to the following conclusions:

1. On the total test the achievement of the grade eight and grade nine groups is significantly superior to that of grade seven.

2. On the total test there is no difference between the achievement of grade eight and grade nine.

3. On Part One of the test, addition, the achievement of grade eight and grade nine surpass that of grade seven, but there is no difference between grade eight and grade nine.

4. On Part Two of the test, subtraction, there is a very significant difference between the achievement of grade seven and that of grade eight, and between grade seven and grade nine. There is no difference between the achievement of grade eight and that of grade nine.

5. On Part Three of the test, multiplication, the achievement of grade eight and grade nine surpass the achievement of grade seven. There is no difference between the achievement of grade eight and grade nine.

6. On Part Four of the test, division, the achievement of grade eight and grade nine surpass the achievement of grade seven. There is no difference between the achievement of grade eight and grade nine.

7. On Part Five of the test, fractions, decimals, and per cent, the achievement of the grade eight and grade nine surpass that of the grade seven. There is no difference between the achievement of grade eight and grade nine.

8. The test fails to reveal differences between the achievement of grades eight and nine. Various reasons could be given for this, one of them being a weakness in the testing instrument itself.

CHAPTER VI

THE CALIFORNIA DATA

The California Arithmetic Test, Form AA, is divided into two parts, Arithmetic Reasoning and Arithmetic Fundamentals. The Arithmetic Reasoning part is made up of four sub-sections, as follows: (1) Section A deals with number concepts, (2) Section B symbols and rules, (3) Section C numbers and equations, (4) Section D problems. The Arithmetic Fundamentals part is also made up of four sub-sections, as follows: (1) Section E addition, (2) Section F subtraction, (3) Section G multiplication, (4) Section H division. Part One is made up of 55 problems while Part Two is made up of 80 problems, giving a grand total of 135 problems.

1. Number Concepts

The section on number concepts is composed of fifteen items. The first seven problems deal with recognizing numbers. The pupil shows that he knows numbers by selecting a number which is expressed in writing and matching it with one expressed in digits. The next three items deal with Roman numerals. The last five problems deal with recognizing the largest number in a group of numbers. The groups are made up of whole numbers, mixed numbers, decimals, common fractions, and numbers expressed as powers. The achievements of the various grades are given in Table XIX.

TABLE XIX

DISTRIBUTION OF SCORES OBTAINED ON SECTION A,
NUMBER CONCEPTS, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
15	4	6	9
14	28	21	32
13	41	42	35
12	39	27	27
11	16	27	25
10	10	12	6
9	11	12	9
8	4	6	3
7	4	4	3
6	0	0	0
Totals	157	157	149

These data are further illustrated in Figure 7 on the following page. Table XX gives the mean and standard deviations of the various samples.

TABLE XX

MEAN SCORES OF GRADE SEVEN, EIGHT,
AND NINE IN NUMBER CONCEPTS,
CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	12.025	1.798	.143
Eight	11.81	1.84	.147
Nine	12.23	1.71	.140

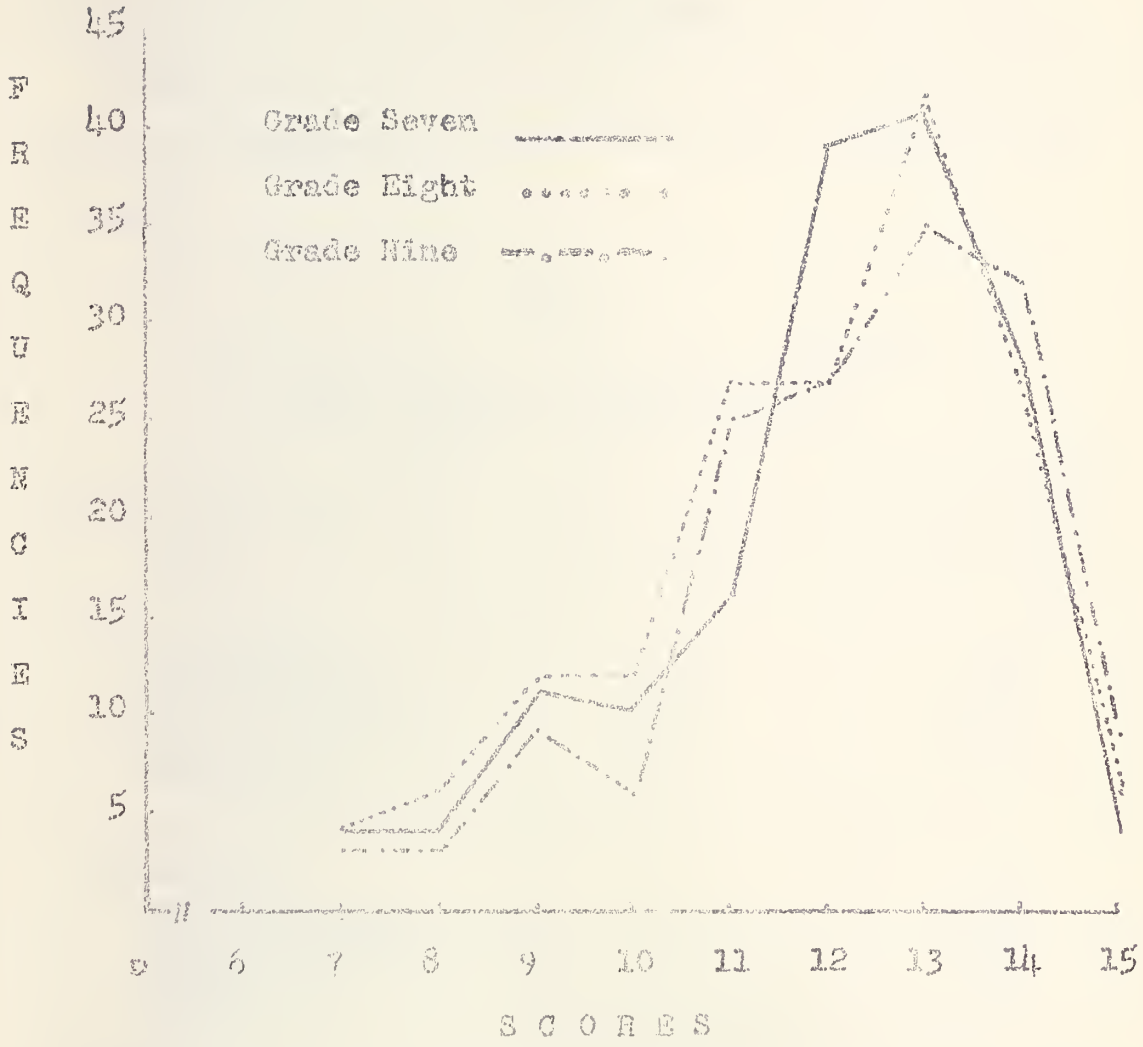


Fig. 7. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section A, Number Concepts.

Grade nine has the highest mean score followed by grade seven, and then grade eight. Grade eight has the highest standard deviation, indicating that there is greatest variability of scores in that grade. The grade nine group has the lowest standard deviation.

Examination of Table XXI reveals no significant mean differences between the achievement of grades seven, eight, and nine in number concepts.

TABLE XXI

MEAN DIFFERENCE IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE, IN NUMBER CONCEPTS, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	.215	.205
SE of difference.....	.205	.200
Critical ratio.....	1.04	1.02
Significance.....	.00	.00
Grade Eight		
Mean difference.....		.42
SE of difference.....		.203
Critical ratio.....		2.06
Significance.....		.00

2. Symbols and Rules

The section on symbols and rules contains fifteen items that test the understanding of the common symbols and rules used in arithmetic. The achievements of the various grades are given in Table XXII.

TABLE XXII

DISTRIBUTION OF SCORES ON SECTION B, SYMBOLS AND RULES, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
15	0	1	36
14	0	17	42
13	7	16	32
12	8	26	12
11	12	24	13
10	8	18	8
9	20	16	3
8	21	14	0
7	28	14	0
6	25	5	2
5	15	5	0
4	4	1	0
3	6	1	0
2	1	0	0
1	0	0	0
Totals	155	158	148

These data are further illustrated in Figure 8 on the following page.

Table XXIII gives the means in the following rank order, grade nine, grade eight and grade seven. The grade eight group has the highest standard deviation.

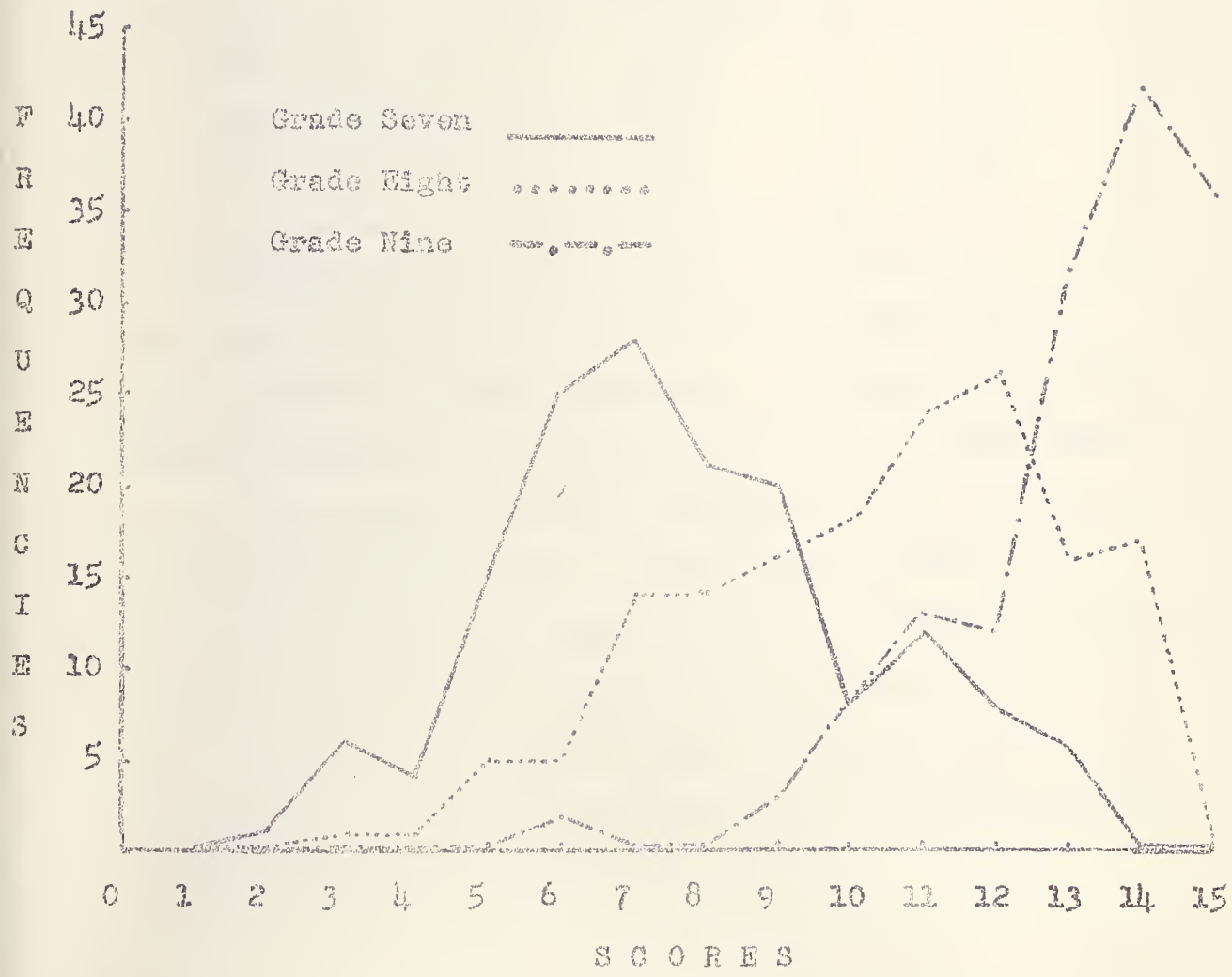


Fig. 8, Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section B, Symbols and Rules.

TABLE XXIII

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE
ON SECTION B, SYMBOLS AND RULES,
CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	7.767	2.49	.200
Eight	10.335	2.52	.2004
Nine	13.17	1.77	.145

Table XXIV reveals a case of normal progression of test scores. The critical ratios indicate highly significant mean differences which lead to the following conclusions: (1) There is a significant difference between the achievement of grade seven and grade eight; (2) there are similar significant differences between the achievement of grade seven and grade nine, and grade eight and grade nine; (3) grade nine has the greatest mastery of the use of symbols and rules, followed by grade eight and then grade seven. This indicates that there is growth in the ability of grade seven, grade eight, and grade nine students in the use of symbols and rules. Theoretically this is as it should be.

TABLE XXIV

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON SYMBOLS AND RULES, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	2.568	5.403
SE of difference.....	.283	.247
Critical ratio.....	9.07	21.87
Significance.....	.01	.01
Grade Eight		
Mean difference.....		2.835
SE of difference.....		.247
Critical ratio.....		11.47
Significance.....		.01

3. Numbers and Equations

The section on numbers and equations contains ten items. The first five problems deal with the operations of addition, subtraction, multiplication, and division of signed numbers. The next five items deal with the solution of equations involving the operations of addition, subtraction, multiplication, division and substitution. The scores obtained by the various grades are given in Table XXV.

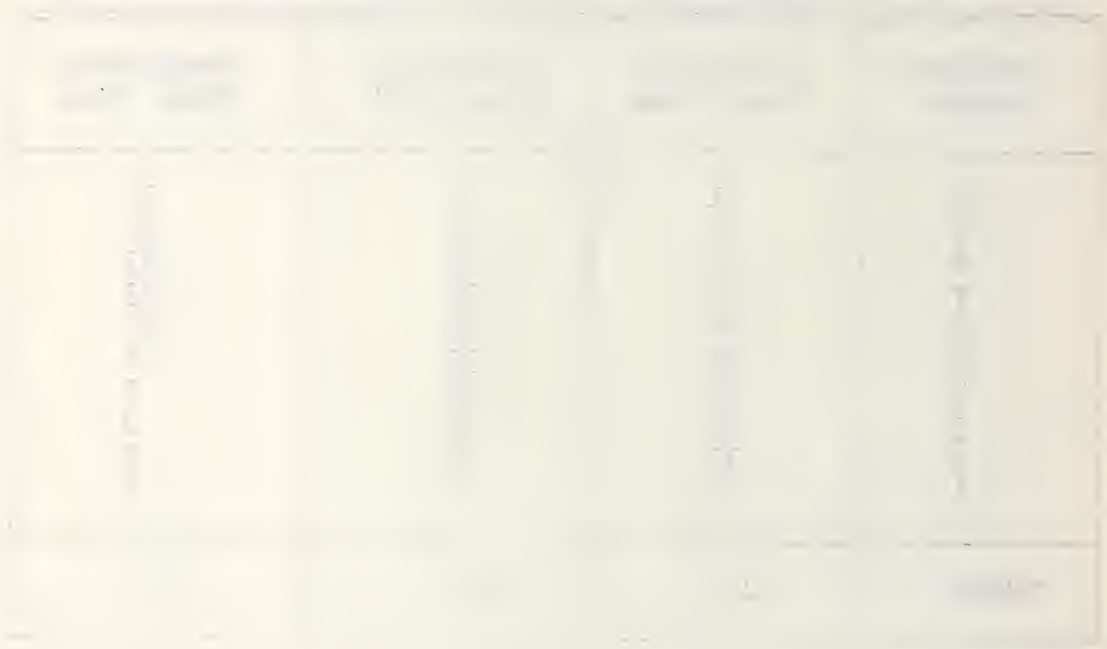
TABLE XXV

DISTRIBUTION OF SCORES ON SECTION C, NUMBERS AND EQUATIONS, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
10	1	4	33
9	1	8	37
8	2	20	33
7	15	30	23
6	22	27	15
5	29	33	5
4	39	18	3
3	26	12	0
2	13	6	0
1	8	0	0
Totals	156	158	149

These data are further illustrated in Figure 9 on the following page. Table XXVI gives the means and standard deviations of the various samples.

Grade nine has the highest mean score followed by grade eight and then grade seven. Grade eight has the highest standard deviation indicating that there is the greatest variation of scores from the mean in that grade.



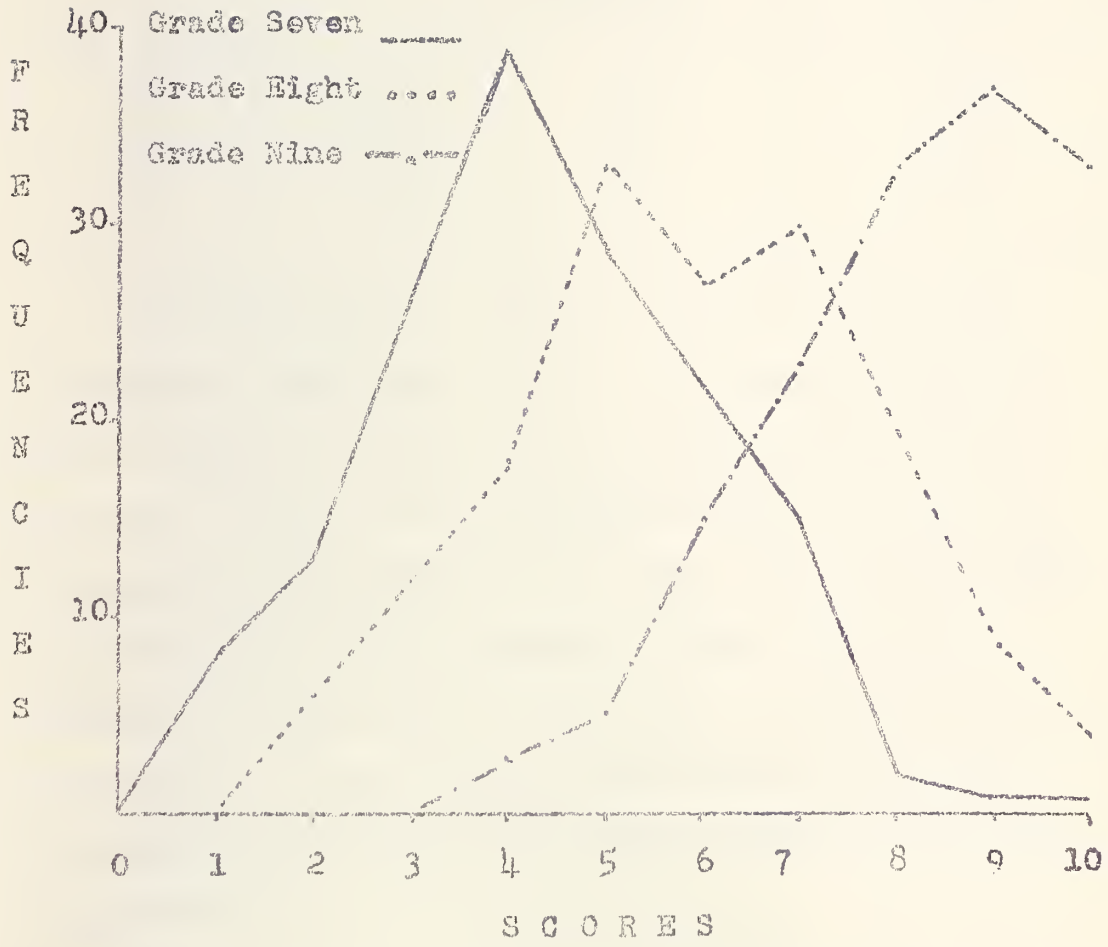


Fig. 9. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section C, Numbers and Equations.

TABLE XXVI

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE
ON SECTION C, NUMBERS AND EQUATIONS,
CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	4.391	1.74	.139
Eight	5.879	1.87	.149
Nine	8.154	1.51	.123

Table XXVII reveals a significant difference between the achievement of grade seven and that of grade eight. There is a similar difference between the achievement of grade seven and grade nine. There is also a significant difference between the achievement of grade eight and grade nine. This shows that there is growth in the ability of students to handle numbers and equations from grade seven to grade eight and from grade eight to grade nine. It is to be noted that discrimination between grade eight and grade nine on the Schorling Hundred Problem Test was non-existent.

TABLE XXVII

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON SECTION C, NUMBERS AND EQUATIONS, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	1.488	3.763
SE of difference....	.203	.185
Critical ratio.....	7.33	20.34
Significance.....	.01	.01
Grade Eight		
Mean difference.....		2.275
SE of difference....		.193
Critical ratio.....		11.78
Significance.....		.01

4. Problems

The section on problems is made up of fifteen items. These are common type problems dealing with the finding of area, volume, averages, per cent, interest, profits, and premiums. The achievement of the various grades is given in Table XXVIII. The rank order of the samples as determined by the means on Section D, is grade nine, eight, and then seven. This is the same as for Sections B, and C. This similarity indicates that the ability in symbols and rules, numbers and equations, and problems increases with age and grade. This again, is further evidence that the California test is measuring better than did the Hundred Problem test. In the section of the Hundred Problem Test that corresponds to this one, the rank order of means was eight, nine, and seven.

TABLE XXVIII

DISTRIBUTION OF SCORES OBTAINED BY GRADE SEVEN EIGHT, AND NINE ON PROBLEMS, SECTION D, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
15	0	10	18
14	3	15	27
13	2	22	35
12	2	21	23
11	14	19	12
10	9	19	11
9	17	17	10
8	20	13	5
7	26	9	3
6	32	6	2
5	17	4	0
4	9	3	1
3	3	1	0
2	1	0	0
1	2	0	0
Totals	157	159	148

These data are further illustrated in Figure 10 on the following page.

TABLE XXIX

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE ON SECTION D, PROBLEMS, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	7.369	2.45	.195
Eight	10.616	2.807	.222
Nine	12.08	2.07	.171

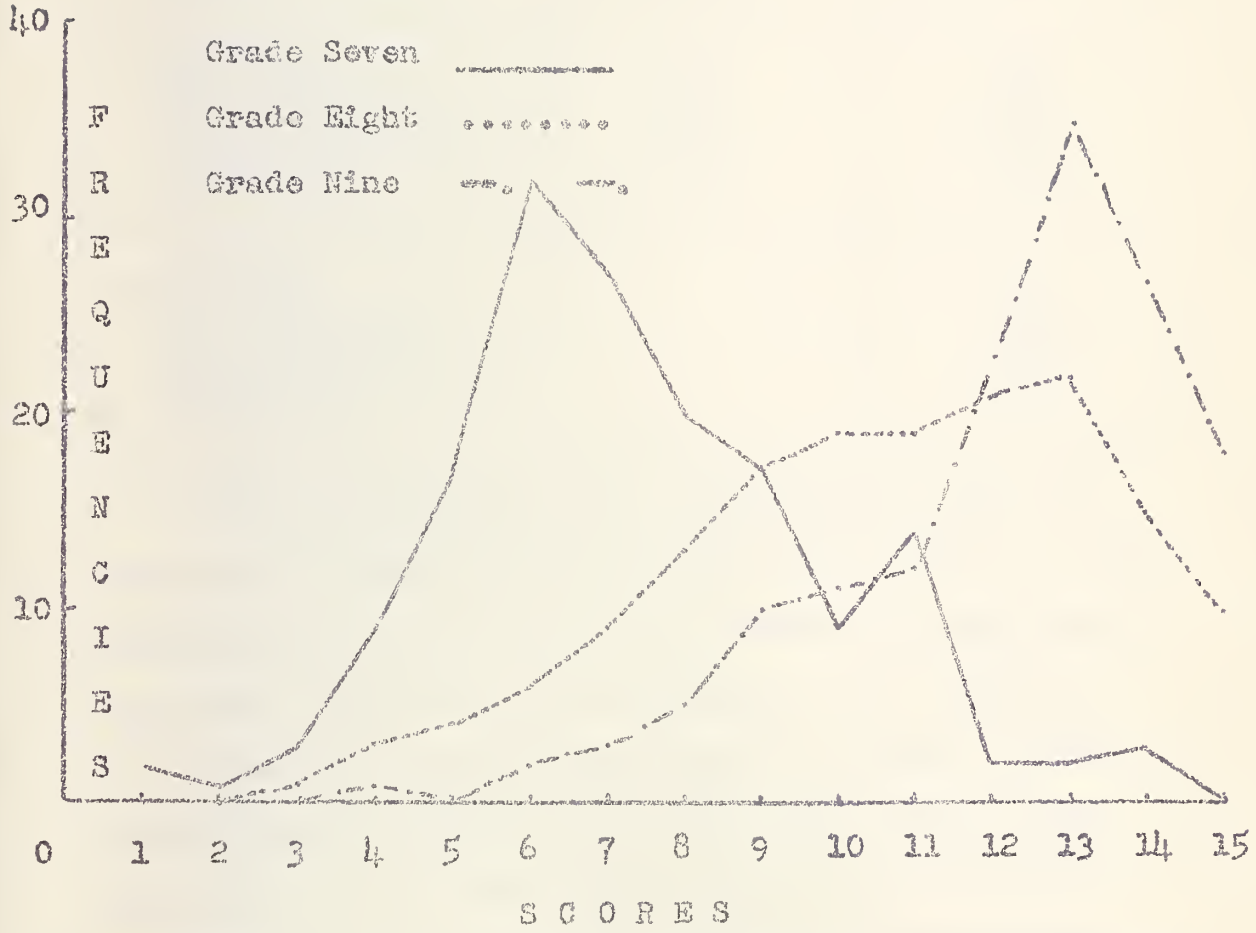


Fig. 10. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section D, Problems.

TABLE XXX

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON SECTION D, PROBLEMS, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	3.247	4.711
SE of difference.....	.296	.259
Critical ratio.....	10.96	18.18
Significance.....	.01	.01
Grade Eight		
Mean difference.....		1.464
SE of difference.....		.280
Critical ratio.....		5.22
Significance.....		.01

A verbal interpretation of this table follows: Grade nine achievement in problems is significantly better than that of either the grade seven or grade eight. The achievement of grade eight is significantly superior to that of the grade seven. According to the California Test results there appears to be growth in problem solving ability from grade seven to grade eight, and from grade eight to grade nine. Since there is a theoretical basis for the correlation of arithmetical scores with age and progress through school it must be assumed that the California test is doing a better job of measuring than did the Hundred Problem.

5. Arithmetic Reasoning, Total Part I

Arithmetic Reasoning forms Part One of the test and consists of fifty-five problems. These problems have been divided into four

subsections: Number Concepts, Symbols and Rules, Numbers and Equations, and Problems. These subsections have been dealt with individually in the early parts of this chapter. The achievement of the various grades on the total test of Arithmetical Reasoning is given in Table XXXII.

The rank order of the samples determined by the means on Part I, Arithmetic Reasoning, of the California Test is the same as that for the subsections which make up this part. This similarity may be regarded as further evidence that the California test is doing a better job of measuring than did the Hundred Problem test. The mean scores and standard deviations are presented in Table XXXI.

TABLE XXXI

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE ON PART ONE, ARITHMETIC REASONING, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	31.66	5.88	.471
Eight	38.683	6.97	.554
Nine	45.63	5.41	.449

These data are further illustrated in Figure 12 on page 56.

TABLE XXXII

DISTRIBUTION OF SCORES IN PART ONE, ARITHMETICAL REASONING, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
55	0	1	0
54	0	0	4
53	0	0	2
52	1	2	8
51	0	2	14
50	0	2	11
49	0	6	14
48	1	3	14
47	0	6	8
46	1	7	7
45	2	7	7
44	1	6	13
43	0	7	4
42	4	9	9
41	2	6	4
40	4	9	4
39	4	6	7
38	4	12	4
37	7	9	1
36	4	10	4
35	8	7	2
34	10	4	1
33	12	5	0
32	11	7	1
31	9	4	0
30	7	4	0
29	10	4	0
28	17	6	1
27	9	0	0
26	9	1	1
25	6	0	0
24	5	2	0
23	2	2	0
22	2	2	0
21	2	0	0
20	1	0	0
19	0	0	0
18	0	0	0
17	0	0	0
16	0	0	0
15	1	0	0
Totals	156	158	145

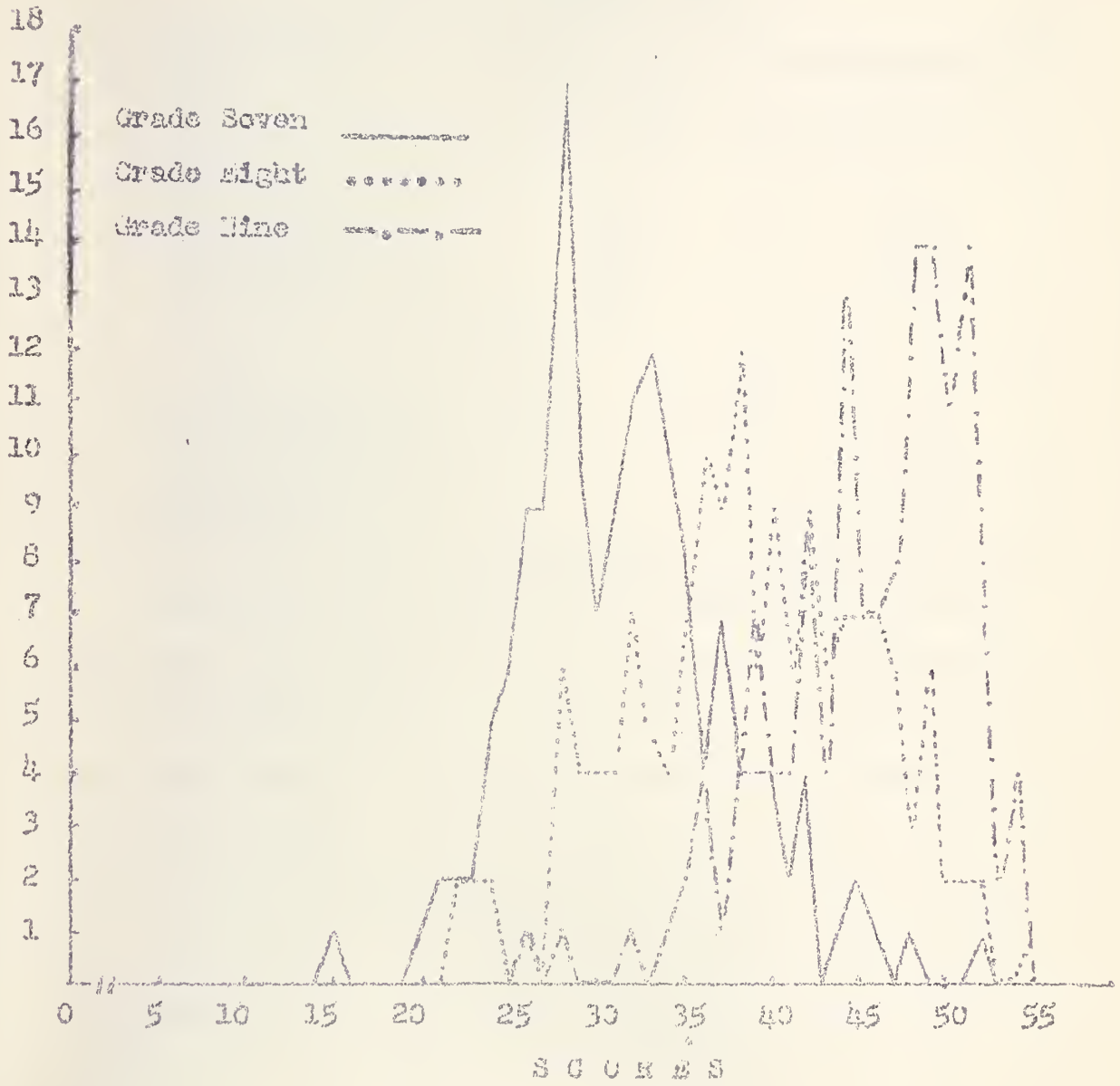


Fig. 11. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Part One, Arithmetic Reasoning.

TABLE XXXIII

COMPARATIVE ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON PART ONE, ARITHMETIC REASONING, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	7.01	13.96
SE of difference.....	.727	.650
Critical ratio.....	9.64	21.47
Significance.....	.01	.01
Grade Eight		
Mean difference.....		6.95
SE of difference.....		.713
Critical ratio.....		9.74
Significance.....		.01

Examination of Table XXXIII reveals highly significant mean differences. The conclusion must be accepted that the differences in mean arithmetic reasoning scores are real differences since they are of such magnitude that they could rarely occur as a result of accident or sampling errors. This table may be interpreted as follows: (1) the grade eight and nine samples are superior to the grade seven sample; (2) the grade nine sample is superior to the grade eight sample. Such differences are normally expected with continued good instruction and increase in age.

6. Part II, Arithmetic Fundamentals

The section on arithmetic fundamentals is composed of four subsections: addition, subtraction, multiplication, and division. Each subsection contains twenty items, giving a total of eighty problems for this section of the test.

7. Addition

The section on addition is composed of problems in column addition, adding money, adding fractions, adding mixed numbers, and adding different units of measurement. The achievement of the various grades is given in Table XXXV. Table XXXIV below, gives the mean scores and standard deviations of the various samples.

TABLE XXXIV

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE ON SECTION E, ADDITION, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	15.506	2.83	.225
Eight	16.28	2.64	.210
Nine	17.05	2.51	.207

TABLE XXXV

DISTRIBUTION OF SCORES IN ADDITION, SECTION E,
CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
20	6	6	16
19	15	26	29
18	19	28	30
17	24	28	22
16	27	23	20
15	18	18	8
14	12	8	9
13	15	4	5
12	10	3	3
11	4	7	0
10	2	4	3
9	4	1	0
8	0	1	0
7	0	1	1
6	1	0	0
5	0	0	0
4	1	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Totals	158	158	146

These data are further illustrated in Figure 12 on the following page.

The grade nine group has the highest mean score, followed by grade eight, and then grade seven. The standard deviation is in exactly the opposite order. All differences are significant, as shown by Table XXXVI. These findings are similar to those of the Schorling test for the achievement of grades seven and eight in addition but not for the relative achievement of grades eight and nine.

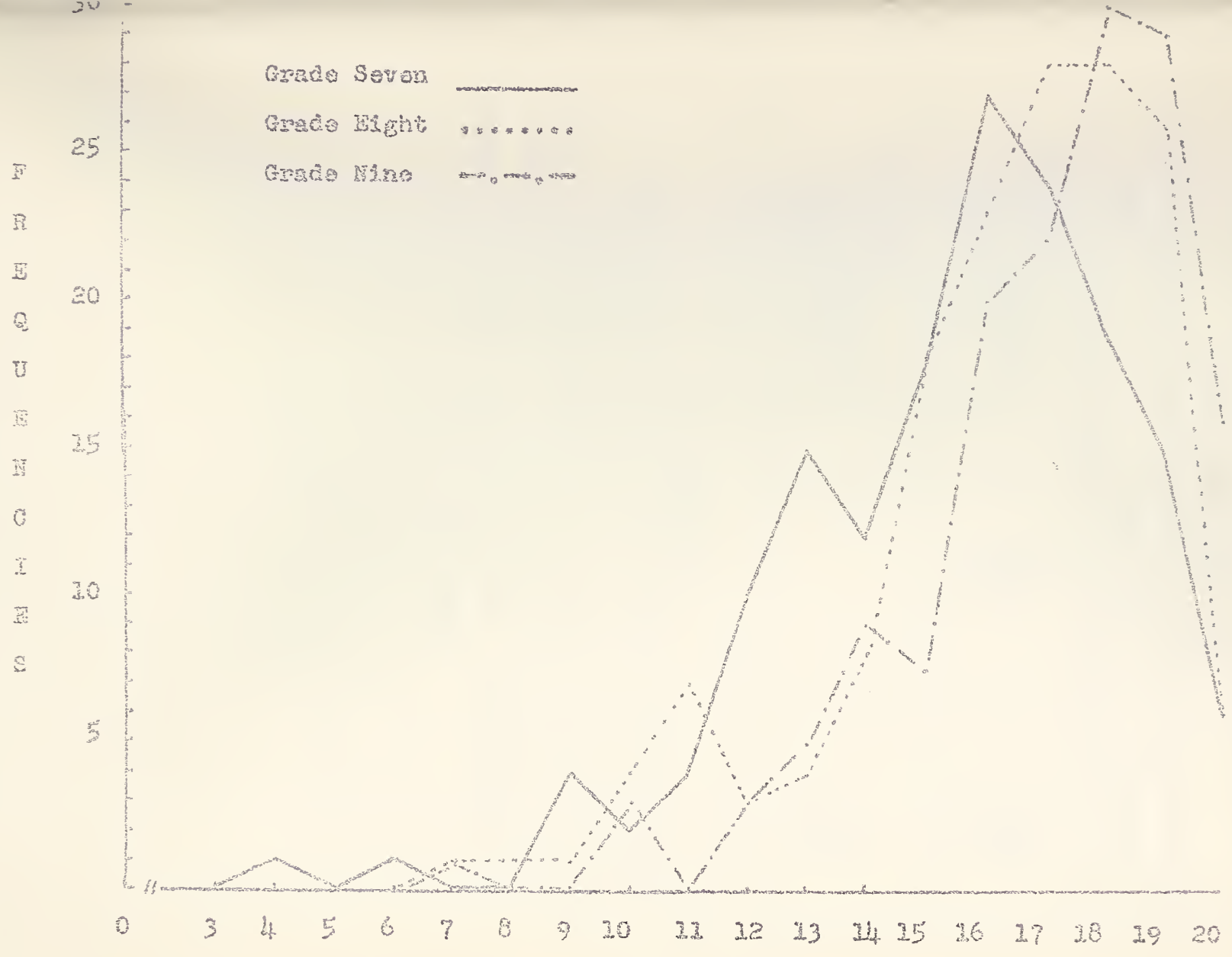


Fig. 12. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test.

TABLE XXXVI

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON SECTION E, ADDITION, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	.78	1.55
SE of difference.....	.307	.305
Critical ratio.....	2.54	5.08
Significance.....	.05	.01
Grade Eight		
Mean difference.....		.77
SE of difference.....		.295
Critical ratio.....		2.61
Significance.....		.01

8. Subtraction

This section of the test is also made up of twenty problems. There are problems in subtraction of two, three, and four digit numbers, of fractions of like and related denominators, of mixed numbers, of decimal numbers and time units. The achievement of the various grades is given in Table XXXVII.

TABLE XXXVII

DISTRIBUTION OF SCORES IN SUBTRACTION, SECTION F,
CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
20	14	27	46
19	25	27	32
18	24	23	16
17	21	18	16
16	14	18	8
15	15	11	13
14	19	11	4
13	9	5	4
12	8	7	3
11	3	2	2
10	1	2	1
9	3	1	0
8	0	1	1
7	0	1	0
6	0	0	0
5	1	0	0
4	0	0	1
3	1	0	0
2	0	0	0
1	0	0	0
Totals	158	154	147

These data are further illustrated in Figure 13 on the following page. The mean scores and standard deviations of the various samples are presented in Table XXXVIII.

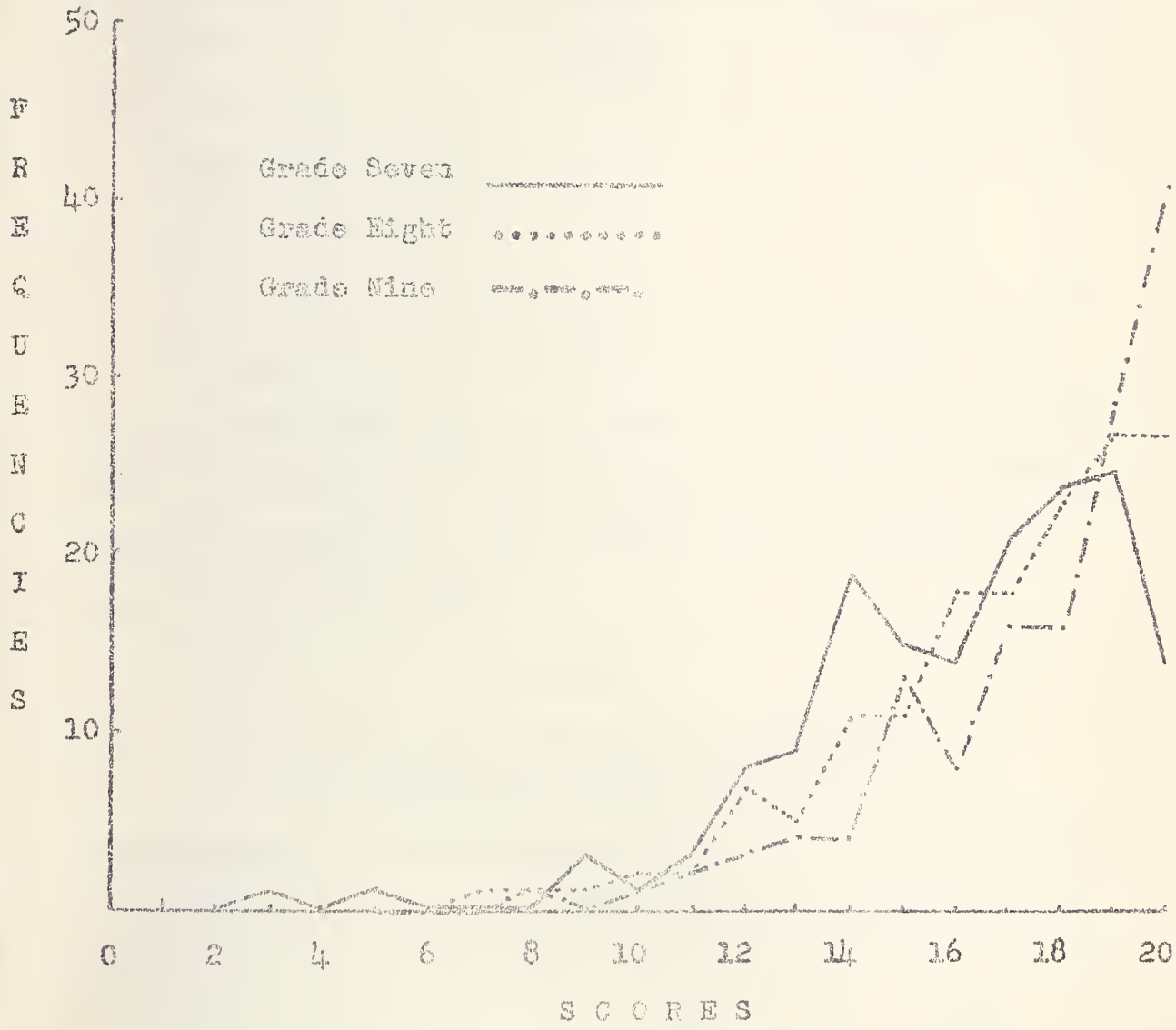


Fig. 13. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section F, Subtraction.

TABLE XXXVIII

MEAN SCORES OF GRADE SEVEN, EIGHT AND NINE ON SECTION F, SUBTRACTION, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	16,139	2.98	.237
Eight	16.85	2.79	.224
Nine	17.68	2.73	.225

The grade Nines have the highest mean score followed by grade eight and then grade seven. The standard deviations occur in reverse order. The differences between the means of the three samples were tested for significance against the table of t. The comparisons appear below in Table XXXIX.

TABLE XXXIX

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON SECTION F, SUBTRACTION, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	.78	1.54
SE of difference.....	.326	.306
Critical ratio.....	2.17	4.72
Significance.....	.05	.01
Grade Eight		
Mean difference.....		.83
SE of difference.....		.317
Critical ratio.....		2.30
Significance.....		.05

Table XXXIX reveals significant mean differences between the achievement of grade seven and of grade eight, grade seven and grade nine, and grade eight and grade nine. The reader is already aware that these results are more defensible, theoretically, than those obtained on the Schorling Test. These findings are similar to those of the Schorling Test for grade seven and grade eight, but the Schorling Test data reveal no difference between the achievement of grades eight and nine.

9. Multiplication

The section in Multiplication is composed of twenty problems. It tests the essential skills required in multiplication of integers, fractions, and decimals. The mean scores and standard deviations of the various samples are given in Table XL, while the distribution of scores is presented in Table XLI.

Grade nine has the highest mean score followed by grade eight, and then grade seven. The standard deviations occur in reverse order. This diminuation of variability from grade seven to grade nine on the California test appears in all parts of the test, leading to the assumption that variability in scores diminish with increase in age and progress through the grades.

TABLE XL

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE
ON SECTION G, MULTIPLICATION,
CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	14.72	2.99	.241
Eight	16.325	2.55	.204
Nine	17.11	2.33	.193

TABLE XLI

DISTRIBUTION OF SCORES OBTAINED BY GRADE SEVEN, EIGHT,
AND NINE IN MULTIPLICATION, SECTION G,
CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
20	5	11	25
19	6	24	33
18	19	25	21
17	17	26	19
16	18	16	10
15	28	17	13
14	18	11	8
13	11	11	6
12	8	8	9
11	8	2	0
10	5	2	0
9	4	2	1
8	8	0	1
7	0	0	0
6	0	0	0
5	0	0	0
4	0	0	0
3	0	0	0
2	0	0	0
1	0	0	0
Totals	155	155	146

These data are further illustrated in Figure 14 on the following page. The examination of Table XLII reveals the expected highly significant mean differences between grades seven, eight, and nine.

TABLE XLII

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE IN MULTIPLICATION, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	1.605	2.389
SE of difference.....	5.315	7.308
Critical ratio.....	5.12	7.75
Significance.....	.01	.01
Grade Eight		
Mean difference.....		.784
SE of difference.....		.280
Critical ratio.....		2.80
Significance.....		.01

There is growth in the ability to handle the mathematical operation of multiplication in each grade, from grade seven to grade eight, and from grade eight to grade nine. These results are verified by the Schorling data for multiplication for grade seven and grade eight, but the Schorling data shows no significant difference in achievement between grade eight and nine. These data demonstrate again the greater suitability for classroom use of the California Test.

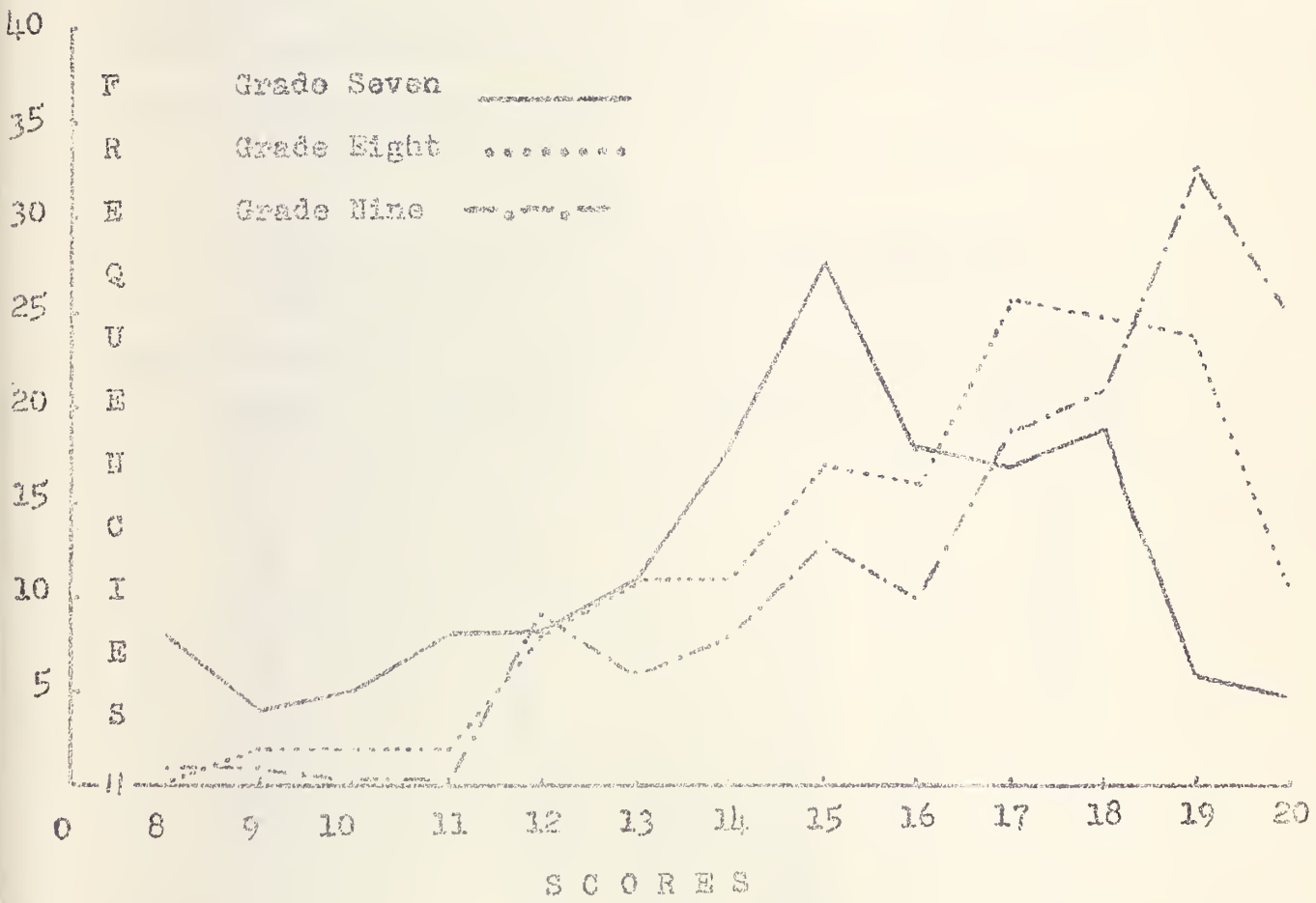


Fig. 14. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section C, Multiplication.

10. Division

The section in division is made up of twenty various type problems testing fundamental abilities required in division. There are questions dealing with the division of fractions by mixed numbers, and division employing decimal divisors. The achievement of the various grades is given in Table XLIII

TABLE XLIII

DISTRIBUTION OF SCORES OF GRADE SEVEN, EIGHT, AND NINE IN DIVISION, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
20	11	23	30
19	18	19	27
18	14	31	29
17	15	20	17
16	24	19	12
15	16	15	10
14	11	8	2
13	13	9	5
12	9	4	6
11	10	2	2
10	5	2	3
9	3	2	0
8	3	0	0
7	3	0	0
6	0	0	0
5	0	0	0
4	0	1	0
3	0	0	0
2	0	0	0
1	0	0	0
Totals	155	155	143

The data of Table XLIII are further illustrated in Figure 15. Table XLIV presents the mean scores and the standard deviations of the samples. The grade nine group has the highest mean score, followed by grade eight, and then grade seven. The reverse order prevails in the standard deviation.

TABLE XLIV

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE IN DIVISION, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	10.49	3.06	.239
Eight	11.98	2.54	.199
Nine	12.458	2.45	.241

Table XLIV reveals that there is a significant difference between the achievement of grade seven and grade eight, and grade eight and nine. The difference between grade eight and nine is significant at the .05 level of confidence. Again, as in addition, subtraction, and multiplication, the findings of the Schorling test are similar to the findings of the California test for the achievement of grade seven and grade eight. But the Schorling test again shows no difference in achievement between grade eight and grade nine.

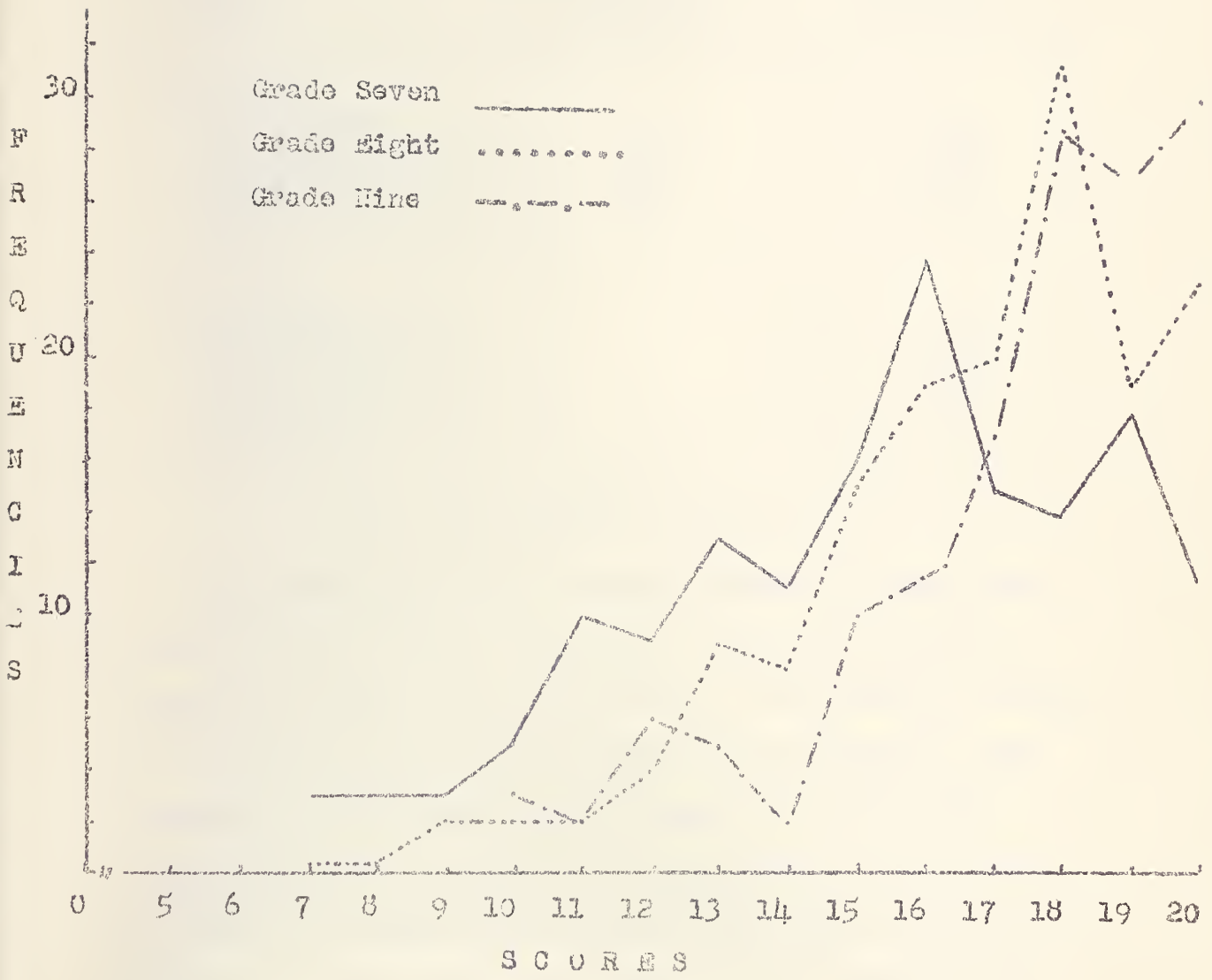


Fig. 15. Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Section II, Division.

TABLE XLV

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE IN DIVISION, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	1.50	2.16
SE of difference.....	.341	.335
Critical ratio.....	4.39	6.44
Significance.....	.01	.01
Grade Eight		
Mean difference.....		.66
SE of difference.....		.304
Critical ratio.....		2.17
Significance.....		.05

11. Total Arithmetic Fundamentals

This section deals with the total achievement of grade seven, eight, and nine on the four fundamental operations of addition, subtraction, multiplication, and division. As the reader is already aware these sub-sections have been dealt with individually. The achievement of the various grades is given in Table XLVI with further illustration of these data in Figure 16. The mean scores and standard deviations are presented in Table XLVII. Grade nine obtained the highest mean score followed by grade eight and then grade seven. This is similar to the rank order of the means of the various sub-sections indicating the steady growth of arithmetical ability in the fundamental processes between the grades.

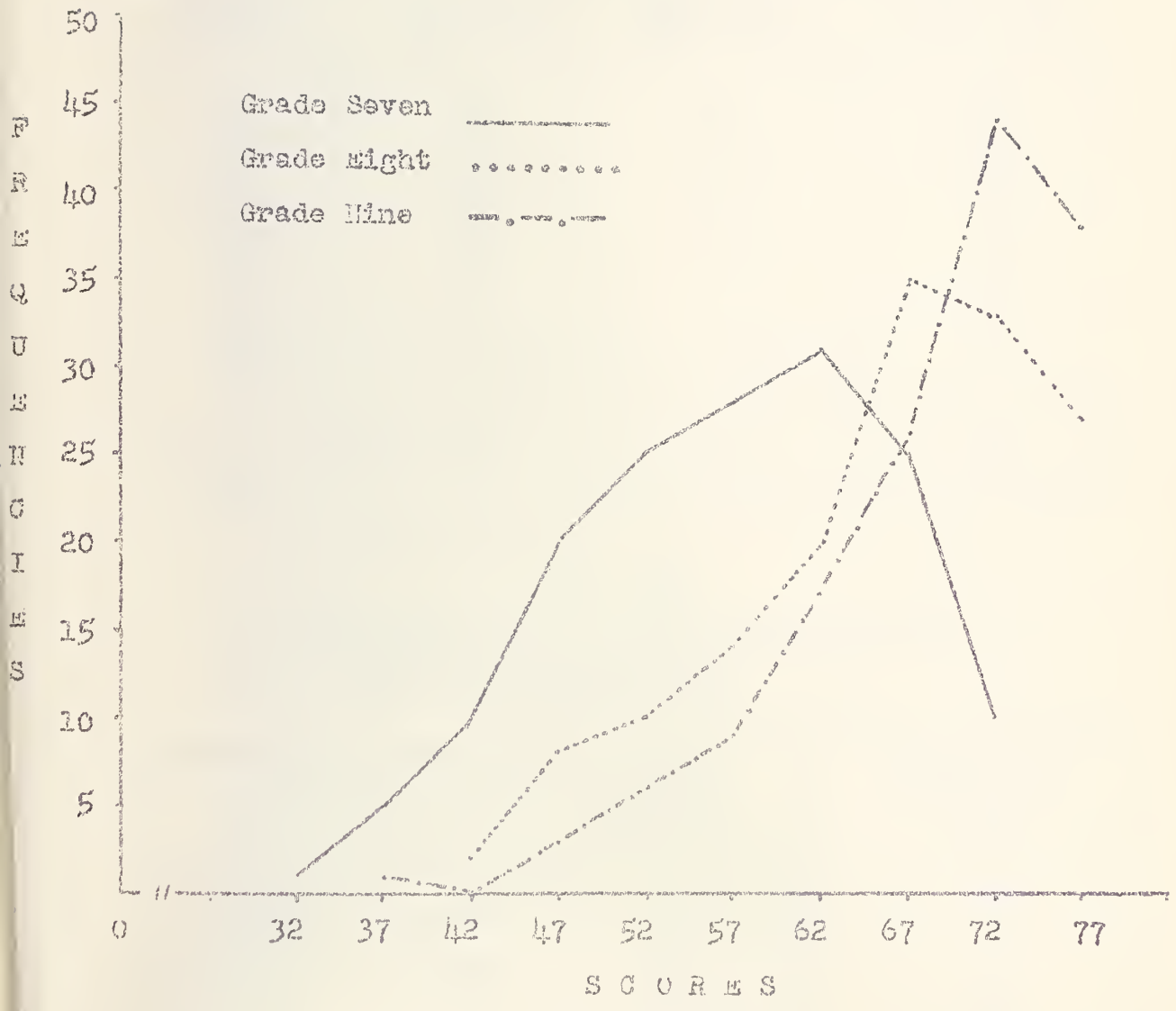


Fig. 16, Distribution of Grade Seven, Eight, and Nine Scores, California Arithmetic Test, Part Two, Arithmetic Fundamentals.

TABLE XLVI

DISTRIBUTION OF SCORES IN GRADE SEVEN, EIGHT, AND NINE ON TOTAL ARITHMETIC FUNDAMENTALS, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
79-75	10	27	38
74-70	25	33	44
69-65	31	35	26
64-60	28	20	17
59-55	25	14	9
54-50	20	10	6
49-45	10	8	3
44-40	5	2	0
39-34	1	0	1
34-30	0	0	0
Totals	155	149	144

TABLE XLVII

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE IN ARITHMETICAL FUNDAMENTALS, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	61.71	9.15	.734
Eight	65.84	8.90	.728
Nine	68.70	8.015	.679

The differences between the means of the three samples were tested for significance against Fisher's table of t. These comparisons appear in Table XLVIII.

The critical ratios found in Table XLVIII indicate highly significant differences between the means of grade seven, eight, and nine. The data indicate that grade eight is superior to grade seven in performing the four fundamental operations of addition, subtraction, multiplication, and division. The data of the Schorling Hundred Problem Test confirms these findings. The grade nine achievement is significantly superior to grade eight, a finding which the Hundred Problem Test does not confirm.

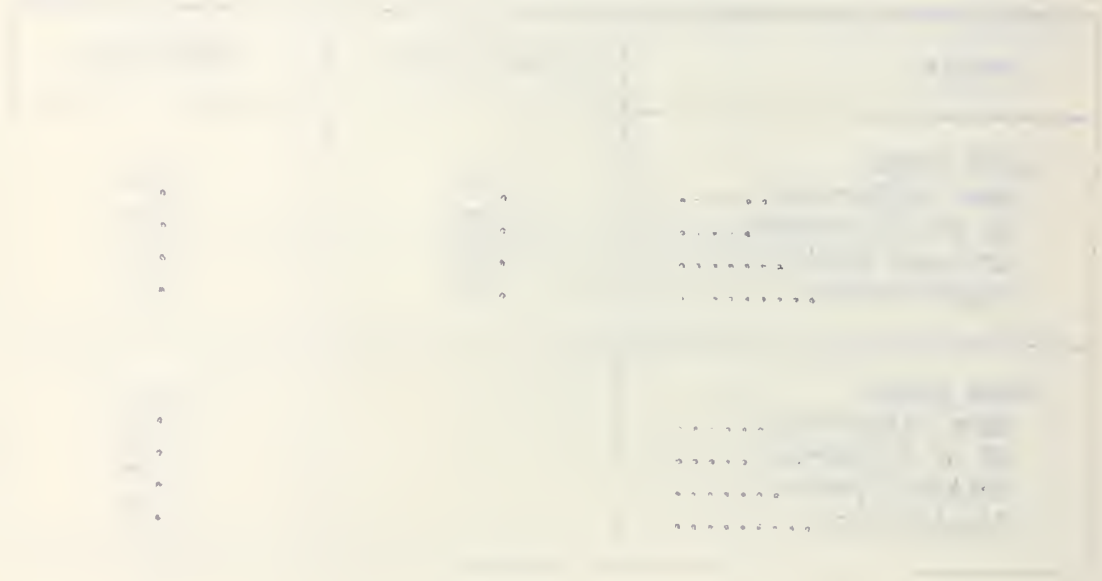
TABLE XLVIII

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE IN ARITHMETICAL FUNDAMENTALS, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	4.13	6.99
SE of difference.....	1.033	.999
Critical ratio.....	3.99	6.99
Significance.....	.01	.01
Grade Eight		
Mean difference.....		2.86
SE of difference.....		.95
Critical ratio.....		2.87
Significance.....		.01

12. Total Arithmetic

The total achievement of grades seven, eight, and nine on the whole test is next considered. The test is made up of 135 problems, which are divided into eight sub-sections which have been dealt with in the earlier parts of this chapter. The total achievement of the



various grades is given in Table XLIX. The mean scores and standard deviations are presented in Table L. Grade nine obtained the highest mean score followed by the grade eight and grade seven. The standard deviations occur in a different order. The grade eight have the highest standard deviation followed by grade seven and then grade nine, indicating that there is the greatest variation of scores from the mean in grade eight. This may be restated by saying that the "spread" or "scatter" of scores about the mean was the greatest in grade eight, or that the range of ability is the widest in this grade. The variability of scores is not as wide in grade seven, and the grade nine group tends to be the most homogeneous of the three samples.

TABLE XLIX

DISTRIBUTION OF SCORES ON TOTAL ARITHMETIC TEST BY GRADE SEVEN, EIGHT, AND NINE, CALIFORNIA ARITHMETIC TEST

Problems Correct	Frequencies Grade Seven	Frequencies Grade Eight	Frequencies Grade Nine
134-130	0	1	10
129-125	1	11	21
124-120	0	14	32
119-115	8	15	22
114-110	12	22	15
109-105	12	16	15
104-100	16	19	11
99-95	23	16	9
94-90	27	13	6
89-85	13	8	2
84-80	22	9	0
79-75	10	1	0
74-70	5	2	2
69-65	4	2	0
64-60	1	1	0
59-55	1	0	0
Totals	155	150	143

These data are further illustrated in Figure 17 on the following page.

TABLE L

MEAN SCORES OF GRADE SEVEN, EIGHT, AND NINE ON THE TOTAL, CALIFORNIA ARITHMETIC TEST

Grade	Mean	Standard Deviation	Standard Error of Mean
Seven	93.48	13.15	1.056
Eight	104.70	14.70	1.20
Nine	114.55	12.35	1.032

TABLE LI

MEAN DIFFERENCES IN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON THE TOTAL ARITHMETIC TEST, CALIFORNIA ARITHMETIC TEST

Sample	Grade Eight	Grade Nine
Grade Seven		
Mean difference.....	11.22	21.07
SE of difference.....	1.60	1.47
Critical ratio.....	7.01	14.33
Significance.....	.01	.01
Grade Eight		
Mean difference.....		9.85
SE of difference.....		1.58
Critical ratio.....		6.23
Significance.....		.01

13. Conclusions

Table LI reveals critical ratios indicating highly significant mean differences. This permits the acceptance of the following conclusions:

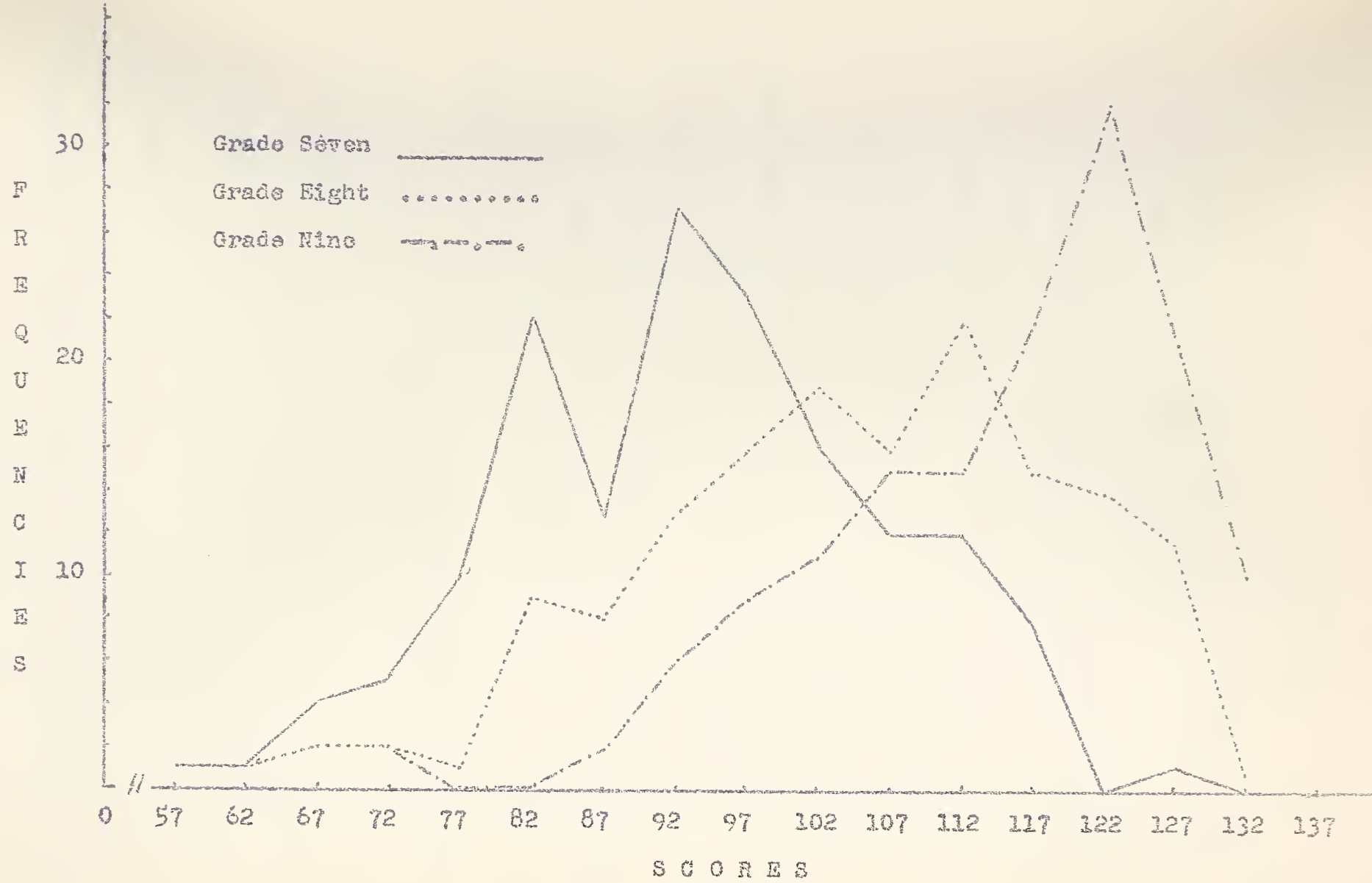


Fig. 17. Distribution of Grade Seven, Eight, and Nine Scores, Total Test, California Arithmetic Test.

1. On the total test grade nine achievement is significantly superior to that of grade eight and grade seven.

2. The achievement of grade eight is significantly superior to that of grade seven. The findings of the California Test data make it reasonable to assume that there is continuous growth in arithmetical attainment throughout the three grade levels of the junior high schools of Lethbridge. The Schorling data are in agreement with this conclusion for grade seven and grade eight, but not so far as the grade nine is concerned. This again shows the failure of the Hundred Problem Test to detect a significant difference between grade eight and nine, a difference which is repeatedly confirmed by the California Test.

3. In sections of the California Test that deal with symbols and rules, numbers and equations, and problem solving, the achievement of the grade nine is significantly superior to that of the grade seven or the grade eight.

4. The achievement of the grade nine is significantly better than the achievement of either the grade seven or the grade eight in arithmetic fundamentals.

5. On the total test the grade nine has attained the highest achievement followed by the grade eight and then the grade seven.

6. The California Test reveals significant differences between the achievement of grades seven, eight, and nine. The Hundred Problem Test indicates differences between grade seven and eight, but fails to demonstrate the existence of difference between grade eight and nine.

CHAPTER VII

COMPARISON OF ACHIEVEMENT

1. Comparison of Lethbridge Achievement With The Hundred Problem Norms

Chapters V and VI were concerned with the question of the relative levels of arithmetical achievement of the grade seven, eight and nine samples of the junior high schools of Lethbridge. The second phase of the study compares the achievement of the Lethbridge samples with the norms of the Hundred Problem and California tests. ,This chapter will attempt to find out if the achievement of the pupils tested in the present investigation compares favorably with that of the standardization samples of the two tests.

As no means, standard deviations, nor grade scores are given for the Schorling standardization sample it is necessary to use a single measure which represents the distribution of scores for the entire group. The standing of the Lethbridge sample in relation to the performance of the national standardization population may be determined by finding the percentile rank corresponding to the median score for the Alberta group.[27] The final grade percentile norms are given in the Manual of Directions, Hundred Problem Arithmetic Test.

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[27]R. Schorling, J.R. Clark, and M.A. Potter, Manual of Directions, Hundred Problem Arithmetic Test. Yonkers-on-Hudson: World Book Company, p. 4.

TABLE LII

MEDIAN AND PERCENTILE SCORES FOR LETHBRIDGE AND SCHORLING SAMPLES, HUNDRED PROBLEM ARITHMETIC TEST

Grade	Lethbridge Median	Percentile Rank	Schorling Median	Deviation*
Seven	69.06	76	53.4	15.66
Eight	78.51	81	61.3	17.21
Nine	79.35	71	68.8	10.55

*Deviation is the difference between same median and Schorling or standardization median.

Table LII reveals that grade eight had a percentile ranking of 81, grade seven 76, and grade nine 71. The table also indicates relatively high deviations of the Alberta sample from the norms. Deviations are taken to mean differences between sample medians and standardization medians. For a class of more than twenty-five a deviation of more than three raw score points from the national standardization median may be considered a significant deviation.[28] It is now reasonable to conclude that the achievement of the grades seven, eight and nine in the Lethbridge junior high schools is significantly better than that of the Schorling standardization sample. The diminishing percentile rank for grade nine as compared with that of grade eight may be explained, perhaps, in terms of the instructional program in that grade, or the ineffectiveness of the measuring instrument in bringing out differences in achievement between grade eight and nine. Since the California Test reveals significant differences the obvious conclusion is that the Hundred Problem Test diminishes in effectiveness at the grade nine level.

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[28] Ibid., p. 4.

2. Lethbridge Results Compared With California Norms

The norms of the California Arithmetic Test have been based on a huge sample which constituted a normal distribution of mental ability, typical age-grade relationships, and other characteristics.[29] These characteristics must be assumed for the samples from the Lethbridge schools if the comparison is to have validity. The test makers use grade-placement and percentile norms. Therefore it will be necessary to make a comparison of the achievement of the Lethbridge samples on these bases. The norms are given for arithmetic reasoning, arithmetic fundamentals, and for the total test. The achievement of grades seven, eight and nine appear in Table LIII.

TABLE LIII

MEAN, GRADE PLACEMENT AND PERCENTILE RANKING OF GRADE SEVEN, EIGHT AND NINE IN ARITHMETIC FUNDAMENTALS, AND TOTAL ACHIEVEMENT, CALIFORNIA ARITHMETIC TEST

Sample	Mean	Possible Score	Grade Placement	Percentile Rank
Grade Seven				
Arithmetic Reasoning	31.66	55	8.6	75
Arithmetic Fundamentals	61.71	80	8.6	75
Total Test	93.48	135	8.6	75
Grade Eight				
Arithmetic Reasoning	38.68	55	9.5	75
Arithmetic Fundamentals	65.84	80	9.2	60
Total Test	104.70	135	9.4	70
Grade Nine				
Arithmetic Reasoning	45.63	55	10.5	75
Arithmetic Fundamentals	68.70	80	9.6	50
Total Test	114.50	135	10.1	60

[29] E.W. Tiegs and W.W. Clark, Manual California Arithmetic Test. Los Angeles: California Test Bureau, 1950, p. 17.

Table LIII reveals that grade seven has a grade placement of 8.6 and a percentile rank of 75. As the tests were administered towards the end of January this gives grade seven a placement of 1.1 grades above their actual position. It is interesting to note that the grade placement and percentile rank of grade seven were the same on the two parts, arithmetic reasoning, arithmetic fundamentals, and on the total test. The grade eight group placed one grade above their grade level in arithmetic reasoning, .7 of a grade above their grade in arithmetic fundamentals and .9 of a grade above their own grade on the total test. Their percentile rank was 75 on arithmetic reasoning, 60 on arithmetic fundamentals and 70 on the total test. Grade nine was 1.0 grades above the California sample in arithmetic reasoning, .1 grades above in arithmetic fundamentals and .6 grades above the norms on the total test. This suggests a relative weakness in the ordinary process involved in Arithmetic Fundamentals.

In answering the question implied at the beginning of this chapter, it is reasonable to say that the pupils of the Lethbridge schools in grades seven, eight, and nine are doing significantly superior work in comparison with the standardization sample of the California test. Although their superiority in fundamental processes is less than in other areas, this superiority is generally confirmed by the comparison of the Lethbridge group with the standardization sample of the Hundred Problem Test.

CHAPTER VIII

AREAS OF STRENGTH AND WEAKNESS IN ACHIEVEMENT IN ARITHMETIC

In this chapter a review of the Hundred Problem and California Test results of the Lethbridge group will be made, emphasizing the areas of strength and weakness in achievement. This will be an attempt to answer the question, "What are the strengths and weaknesses in arithmetic in each of the grades?" The Hundred Problem Test data will be considered first.

1. Hundred Problem Test Results

Table LIV reveals the achievement of grades seven, eight and nine on the Schorling Hundred Problem Test, giving the mean scores on each sub-section and for the total test. As the test makers have not supplied norms for any of the sub-sections, there is no reliable standard with which to compare sub-scores in order to determine just how good they are. Therefore it is necessary to rely on a comparison of mean achievement with possible achievement.

TABLE LIV

MEAN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE ON SUB-SECTIONS AND TOTAL, HUNDRED PROBLEM ARITHMETIC TEST

Parts	Mean Scores Grade Seven	Mean Scores Grade Eight	Mean Scores Grade Nine	Possible Scores
I. Addition	7.9	8.4	8.6	10
II. Subtraction	8.5	9.0	9.0	10
III. Multiplication	11.4	12.5	12.8	15
IV. Division	10.5	12.0	12.5	15
V. Fractions, Decimals and Per Cent	29.5	35.0	34.5	50
VI. Totals	67.6	76.8	77.1	100

In addition out of a possible score of 10 the grade seven class achieved a mean score of 7.9, the grade eight class had a mean score of 8.4, and the grade nine group had a mean score of 8.6. If these scores were converted to percentages they would be 78.56 per cent, 84.27 per cent, and 85.9 per cent. This means that the achievement of half the grade seven class is above 78.56 per cent, half the grade eight group is above 84.27, and half of the grade nine sample is above 85.9 per cent. It is reasonable to conclude that this is an area of strength. The distribution of scores in addition, as given in Table I, reveals that twenty-five grade seven, forty-eight grade eight and forty-two grade nine obtained perfect scores on this sub-section. Figure 1, reveals that the distribution curves are negatively skewed, indicating that there is a piling up of scores at the top, with the

result that excellent pupils are not being measured to the limits of their arithmetical competence.

The mean scores in subtraction are also high. Grade seven has a mean score of 8.5, grade eight 9.0, and grade nine 9.0, out of a possible ten items. Figure 2, gives the distributions for subtraction. These curves have a greater degree of negative skewness than those for addition. Table IV, reveals that fifty grade seven, sixty-eight grade eight, and sixty-four grade nine students obtained perfect scores in subtraction. In terms of percentages this means that 31.25 per cent of the grade seven, 40.49 per cent of the grade eight, and 44.44 per cent of the grade nine were perfect scores. From this evidence it is reasonable to conclude that subtraction is also an area of strength, and that the test did not measure top students adequately.

The mean scores in multiplication are: grade seven 11.4, grade eight 12.5, and grade nine 12.5. This is out of a possible score of 15. Figure 3, gives the distribution curves for multiplication. These curves approach normalcy with only a slight amount of skewness. According to Table VII, nine grade seven, twenty-two grade eight, and twenty-eight grade nine pupils obtained perfect scores. From the above evidence it is reasonable to conclude that multiplication can be regarded as an area of strength.

The distribution curves for division scores are somewhat similar to those for multiplication, with a little more negative skewness. These are given in Table X. They reveal that twelve grade seven, twenty-four grade eight and thirty grade nine students obtained

perfect scores. It is reasonable to conclude that there is also strength in this area.

On the sub-section dealing with Decimals, Fractions and Per Cent, the frequency distribution curves are approaching normal for all grades. These are given in Figure 5. There were zero grade seven, zero grade eight and one grade nine student that obtained a perfect score. It may be assumed that the achievement of all samples in this area is relatively weaker, and that the test performed its task of measuring in an adequate manner.

On the total test there was one grade seven student that obtained a perfect score, as compared with six grade eight, and four grade nine pupils that achieved this. The distribution curves for total scores are near normal for all grades with a slight amount of negative skewness. These curves are given in Figure 6. The grade seven group obtained a total mean score of 67.6, the grade eight 76.8, the grade nine 77.1. As there were 100 problems on the test these figures can also be interpreted as percentages.

On all parts of the test the achievements of grade seven, eight, and nine are relatively similar. When the scores were high for grade seven they were high for grade eight and nine. When the scores were low for grade seven they were low for grade eight and nine. The high scores were obtained in the sub-sections dealing with addition, subtraction, multiplication and division, while the lowest scores were obtained on the section dealing with decimals, fractions, and per cents.

2. Conclusions

Analysis of data obtained from the survey of arithmetic achievement in Lethbridge led to the following conclusions:

1. The grade seven, eight, and nine groups obtained the highest mean scores on Part Two, subtraction, of the Hundred Problem Arithmetic Test.

2. On all parts of the test the mean achievements of grades seven, eight, and nine were relatively similar. When the scores were high for grade seven they were high for grades eight and nine. On the other hand when the scores were low for grade seven they were low for grades eight and nine.

3. The second highest scores on a sub-section were on addition, Part One. All grades scored the third highest on part three, multiplication. The scores on Part Four, division were lower and the lowest scores were obtained by all grades on part five, decimals, fractions and per cents.

4. The distribution curves were closest to normal on Part Five, decimals, fractions, and per cents. The curves were also normal for total achievement, multiplication, and division.

5. The greatest piling up of scores at the top was in subtraction and addition.

6. The strongest areas of achievement were subtraction, addition, and multiplication. The weakest areas were: decimals, fraction, and per cent, and division.

7. The test measures well the achievement on parts four, five, and totals. Too many pupils obtained perfect scores for

parts one, two, and three, indicating that the achievement of these students was not fully measured.

8. It is recommended that the teachers of mathematics in the junior high schools of Lethbridge give renewed attention to the teaching of decimals, fractions and per cent, with a view to raising the level of pupil attainment in these areas.

3. California Arithmetic Test Results

Since the test makers have not supplied norms for any of the sub-sections of the California Test a comparison of achievement in these areas is difficult. Therefore it will again be necessary to compare the mean achievement with possible achievement. Table LV reveals that the achievement of grade seven is better on Part Two, Arithmetic Fundamentals, than it is on Part One, Arithmetic Reasoning. The mean score for grade seven, Arithmetic Fundamentals is 61.7, while for Arithmetic Reasoning is 31.7. The frequency distribution curve for Part One, as seen in Figure 11 is normal while the frequency curve for Part Two, Figure 16, is negatively skewed. Not one of the grade seven students obtained a perfect score for Part One in comparison with ten that scored perfectly on Part Two. On Part One grade seven students obtained highest mean scores in number concepts, and symbols and rules. Lowest mean scores were obtained in problems, and numbers and equations. The distribution curves for all the above sub-sections were normal in all cases, indicating that the tests were measuring well.

On Part Two, Arithmetic Fundamentals, the grade seven obtained highest mean scores in subtraction and addition. Lowest mean scores were obtained in multiplication and division. The distribution curves for these sub-sections have a slight amount of skewness. This may result from easy items of the test or some other technical fault.[30]

TABLE LV

MEAN ACHIEVEMENT OF GRADE SEVEN, EIGHT, AND NINE, CALIFORNIA ARITHMETIC TEST

Parts	Mean Scores Grade Seven	Mean Scores Grade Eight	Mean Scores Grade Nine	Possible Scores
A. Number Concepts	12.0	11.8	12.2	15
B. Symbols and Rules	7.8	10.3	13.2	15
C. Numbers and Equations	4.4	5.9	8.2	15
D. Problems	7.4	10.6	12.1	15
Total Arithmetic Reasoning	31.6	38.7	45.6	55
E. Addition	15.5	16.3	17.1	20
F. Subtraction	16.1	16.9	17.7	20
G. Multiplication	14.7	16.3	17.1	20
H. Division	15.2	16.7	17.4	20
Total Arithmetic Fundamentals	61.7	65.8	68.7	80
Total Arithmetic	93.5	104.7	114.6	135

On Part One, Arithmetic Reasoning, grade eight obtained highest mean scores on Sub-sections A and D, Number Concepts and Problems. The lowest mean scores were obtained by the grade eight on Sub-sections B and C, Symbols and Rules, and Numbers and Equations. The distribution curves for all sub-sections for grade eight and in Part One are normal, indicating that the tests are measuring well in these areas.

On Part Two, Arithmetic Fundamentals, the grade eight mean scores are approximately the same for each sub-section. The highest mean scores of 16.9 and 16.7 were obtained on Sections F and H, Subtraction and Division. The lowest mean scores of 16.3 and 16.3 were obtained by grade eight on Sections A and G, Addition and Multiplication. The distribution curve for Section E, Addition is negatively skewed. In Subtraction, Section F, there is a piling up of scores at the top. There were twenty-seven of the grade eight pupils that got all the problems correct in this section. The distribution curves for Sections G and F, Multiplication and Division, show negative skewness. This appearance of negative skewness may be attributed to the fact that some of the test items in the above areas are too easy.

On Part One of the California Arithmetic Test the grade nine mean achievement was the highest for Section B, Symbols and Rules. The mean score was 13.2. On Section C, Numbers and Equations, the mean score was 8.2 the second highest for the sub-sections of Part One. The lowest scores were obtained by grade nine on Sections A and D, Number Concepts and Problems. The distribution curve for Section A, Number Concepts, is normal with a slight degree of negative skewness. The distribution curve for Section B, Symbols and Rules, has considerable negative skewness. There is a piling up of scores at the top end of the distribution. Thirty-six grade nine, or about one-quarter of the sample, got all the problems correct in this section. The distribution curve for Section C, Numbers and Equations, is the same as that for Section B. There

were thirty-three students who had all the problems correct in this section. The test is doing a better job of measuring in Section D, than it did in Sections A, B, or C, as the distribution curve for this section is more nearly normal.

The mean scores for grade nine on Part Two of the California Arithmetic Test are approximately the same on all sub-sections. On Sections E, F, G, and H, Addition, Subtraction, Multiplication, and Division, the mean scores were: 17.1, 17.7, 17.1, and 17.4. The distribution curves for the above sub-sections of Addition, Subtraction, Multiplication, and Division show considerable amounts of negative skewness. There is a piling up of scores at the top end of the distributions indicating that there are too many easy items in the test for grade nine.

4. Summary

The grade seven group has a higher mean score for arithmetic fundamentals than it has for arithmetic reasoning. Areas of strength appear in addition, subtraction, division, and in number concepts. This is to be expected as the grade seven pupils have had most of their arithmetical experience in these areas. Weakness appears in multiplication. Recent studies indicate that multiplication is the most difficult of the four fundamental processes.[31] Further weaknesses appear in symbols and rules, numbers and equations, and problems. The grade eight group shows strength in all the fundamental operations: addition, subtraction, multiplication, division and number concepts. Weaknesses appear in symbols

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[31] G.M. Wilson, "Arithmetic," Encyclopedia Educational Research, 1950.

and rules, numbers and equations, and problems. The grade nine obtained high scores in all sections.

5. Conclusions

Analysis of the California data obtained from the survey of arithmetic achievement in Lethbridge led to the following conclusions:

1. On Part One, Arithmetic Reasoning of the California Test, grade seven obtained their highest mean scores on Sections A and B, Number Concepts, Symbols and Rules, grade eight obtained their highest mean scores on Sections A and D, Number Concepts and Problems, while grade nine obtained their highest mean scores on Sections B and C, Symbols and Rules, and Numbers and Equations.

2. On Part One of the test the lowest mean scores were obtained by grade seven on Sections C and D, Numbers and Equations, and Problems, grade eight obtained their lowest mean scores on Sections B and C, Symbols and Rules, and Numbers and Equations, while the grade nine sample were lowest in Sections C and D, Numbers and Equations, and Problems.

3. On Part Two of the test grade seven group obtained their highest mean scores on Sections E and F, Addition and Subtraction, both grade eight and grade nine obtained their highest mean scores on Sections F and H, Subtraction and Division. The lowest mean scores obtained by grade seven were on Sections G and H, Multiplication and Division, while both grades eight and nine obtained their lowest mean scores on Sections E and G, Addition and Multiplication.

4. All of the grades obtained higher mean scores on Part Two of the test, Arithmetic Fundamentals than on Part One, Arithmetic Reasoning.

5. The California Arithmetic Test measured well the achievements of grades seven and eight throughout all sections of the test. The top students in grade nine were not fully measured in Sections B, D, F, and G. Nevertheless, the California Arithmetic Test did a better job of measuring student achievement in arithmetic than did the Hundred Problem Test. Therefore, the test can be useful for measuring achievement in our schools.

6. The findings of the Hundred Problem Test reveal that the achievement of all grades is favorable in addition, subtraction, multiplication, and less favorable in division, decimals, fractions, and per cent. On the other hand the California Test findings reveal that all grades achieved higher mean scores in Arithmetic Fundamentals than they did in Arithmetic Reasoning. Although grades seven and eight compared more favorably with their test norms on Arithmetic Reasoning than on Arithmetic Fundamentals, the converse was the case in grade nine.

CHAPTER IX

CONCLUSIONS

1. The Hundred Problem Arithmetic Test results revealed that the achievement of all grades in addition, subtraction, and multiplication, was more favorable than it was in division, and decimals, fractions, and per cent. The test showed no significant difference between the achievement of grades eight and nine. The achievement of all grades was significantly superior to that of the Hundred Problem standardization samples.

2. The California Test findings revealed growth in arithmetical competence from grade seven to grade eight, and from grade eight to grade nine. Although the pupils of the Lethbridge schools in grades seven, eight, and nine are doing significantly superior work in comparison with the California standardization sample there is indication that their superiority in fundamental processes is less than in other areas.

3. The Hundred Problem Arithmetic Test fails to discriminate between the achievement of grades eight and nine, and in many cases fails to measure the full competence of the excellent students. The California Test is doing a much better job and can be recommended for use in our schools.

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APPENDIX

HUNDRED-PROBLEM ARITHMETIC TEST

WHOLE NUMBERS—COMMON FRACTIONS—DECIMAL FRACTIONS—PER CENTS

By Raleigh Schorling
Head of Department of Mathematics, the University High School, and Professor of Education, University of Michigan
John R. Clark
The Lincoln School, Teachers College, Columbia University
and Mary A. Potter
Supervisor of Mathematics, Public Schools, Racine, Wisconsin

V

Total Number Right	
%-ile Rank	

TEST: FORM V

Name..... Date..... Grade.....

Age.....years and.....months. Teacher.....

School..... City..... State.....

Directions

Do not turn this page until you are told to do so. Read the following directions.

This test contains several groups of arithmetic examples. When you finish one group, go right on to the next. If you come to an example that you cannot do, skip it and try it again later if you have time. Begin at the top of each column and work down the page.

You are not expected to finish every example, but work steadily and do the best you can.

You may do your figuring on the test paper or on the blank paper that has been given you. But you must be sure to **write the answer to each example in the box near the example.**

Do not turn the page until I say the word *Begin*.

Parts	Number Correct +	Number Wrong +	Number Omitted =	Total Number
I. Addition.....	+	+	=	10
II. Subtraction.....	+	+	=	10
III. Multiplication.....	+	+	=	15
IV. Division.....	+	+	=	15
V. Fractions, Decimals, and Per Cents....	+	+	=	50
VI. Total.....	+	+	=	100

[This test is a revision of the *Schorling-Clark-Potter Arithmetic Test*, Form A (1928).]

Published by World Book Company, Yonkers-on-Hudson, New York, and Chicago, Illinois
 HPAT:V-19

PRINTED IN U.S.A.

a

I. ADDITION

Add:

1. 8 7 3 6 9 5 8 = ☐ (1)

2. 463 + 877 + 539 + 198 = ☐ (2)

3. $386.85 + 96.66 + 6.57 + .98 + 100.00 + 5.94 + 60.00 = ☐ (3)

4. $\frac{7}{10}$ + $\frac{3}{5}$ = ☐ (4)

5. $\frac{7}{8} + \frac{3}{16} =$ ☐ (5)

6. $17\frac{5}{6}$ + $5\frac{1}{3}$ = ☐ (6)

7. $\frac{3}{5} + \frac{1}{2} + \frac{7}{10} =$ ☐ (7)

8. $9\frac{3}{4}$ + $27\frac{7}{8}$ + $8\frac{9}{16}$ = ☐ (8)

9. $.07 + 5.23 + 8.29 + 1.40 =$ ☐ (9)

10. $\$2.25 + \$14.70 =$ ☐ (10)

When you finish this part, go right on with the next.

II. SUBTRACTION

Subtract:

11. 1124 − 742 = ☐ (11)

12. 880.75 − 785.78 = ☐ (12)

13. $\frac{11}{12} - \frac{1}{6} =$ ☐ (13)

14. $8\frac{3}{8}$ − $5\frac{3}{4}$ = ☐ (14)

15. $2\frac{3}{4} - \frac{2}{3} =$ ☐ (15)

16. $\$5.04 - 18¢ =$ ☐ (16)

17. $9.752 - 6.007 =$ ☐ (17)

18. $\$32 - \$6.58 =$ ☐ (18)

19. $9.25 - 2.20 =$ ☐ (19)

20. 9006 − 4039 = ☐ (20)

When you finish this part, go right on with the next.

III. MULTIPLICATION

Multiply:

Do your work here.
95
82

21. 95 × 82 = ☐ (21)

Write your answer in the box.

Do your work here.
609
40

22. 609 × 40 = ☐ (22)

Write your answer in the box.

Do your work here.
769
708

23. 769 × 708 = ☐ (23)

Write your answer in the box.

24. $\frac{3}{4} \times 60 =$ ☐ (24)

25. $\frac{5}{4} \times \frac{3}{2} =$ ☐ (25)

26. $\frac{5}{8} \times \frac{12}{10} =$ ☐ (26)

27. $45 \times \frac{2}{5} =$ ☐ (27)

28. $20\frac{3}{5} \times 12 =$ ☐ (28)

29. $1\frac{1}{2} \times 2\frac{1}{4} \times \frac{3}{4} =$ ☐ (29)

Do your work here.
4.928
3.2

30. 4.928 × 3.2 = ☐ (30)

Write your answer in the box.

(Part III is continued on the next page.)

III. MULTIPLICATION

(*Continued*)

The answers in the following examples have not been "pointed off." Put the decimal point in each answer where it belongs.

31. $20 \times .20 =$ 400 (31)

32. $1.6 \times 0.3 =$ 48 (32)

33. $0.5 \times 5 =$ 25 (33)

34. $0.245 \times 2 =$ 490 (34)

35. Does 1.2×0.5 equal 6.0 or .60 or .060 or 60? ____ (35)

When you finish this part, go right on with the next.

IV. DIVISION

Divide:

36. $36 \div 3 =$ ____ (36)

37. $636 \div 6 =$ ____ (37)

38. $948 \div 9 =$ ____ (38)

39. $.004\overline{).0284}$ ____ (39)

40. $.34\overline{)105.4}$ ____ (40)

The answers in the following examples have not been "pointed off." Place the decimal point in each answer where it belongs, adding zeros when necessary.

41. $.123\overline{)560.88}$ 456 (41)

42. $1.23\overline{).56088}$ 456 (42)

43. $12.3\overline{)56.088}$ 456 (43)

44. Does $4786 \div 10$ equal 4.786 or 47.86 or 478.6 or 4786? ____ (44)

45. $2\frac{1}{2} \div 4\frac{1}{2} =$ ____ (45)

46. $3\frac{3}{4} \div \frac{3}{4} =$ ____ (46)

47. $\frac{3}{8} \div 4 =$ ____ (47)

48. $4\frac{1}{2} \div 8 =$ ____ (48)

49. $21\overline{)882}$ ____ (49)

50. $83\overline{)11371}$ ____ (50)

When you finish this part, go right on with the next.

V. FRACTIONS, DECIMALS, AND PER CENTS

Write each of the following as per cent:

SAMPLE $\frac{1}{5} =$ (Your answer should read $\frac{1}{5} = 20\%$.)

51. $\frac{3}{100} =$ ____ % (51)

52. $\frac{3}{5} =$ ____ % (52)

53. $\frac{5}{8} =$ ____ % (53)

54. $.75 =$ ____ % (54)

55. $.075 =$ ____ % (55)

56. $\frac{4}{5} =$ ____ % (56)

57. $\frac{1}{3} =$ ____ % (57)

58. $\frac{3}{8} =$ ____ % (58)

59. $.2 =$ ____ % (59)

60. $0.875 =$ ____ % (60)

Write each of the following as a decimal fraction:

61. $\frac{3}{10} =$ ____ (61)

62. $\frac{1}{4} =$ ____ (62)

63. $\frac{2}{5} =$ ____ (63)

64. $60\% =$ ____ (64)

65. $7\frac{1}{2}\% =$ ____ (65)

66. $\frac{7}{100} =$ ____ (66)

67. $\frac{3}{5} =$ ____ (67)

68. $\frac{1}{8} =$ ____ (68)

(*Part V is continued on the next page.*)

PART V. *(Continued)*

Write each of the following as a decimal fraction:

69. $12\frac{1}{2}\% =$ ☐ (69)

70. $37\frac{1}{2}\% =$ ☐ (70)

Write each of the following as a common fraction:

71. $20\% =$ ☐ (71)

72. $9\% =$ ☐ (72)

73. $25\% =$ ☐ (73)

74. $12\frac{1}{2}\% =$ ☐ (74)

75. $33\frac{1}{3}\% =$ ☐ (75)

Complete the following:

76. 25% of $120 =$ ☐ (76)

77. 2.3% of $40 =$ ☐ (77)

78. 120% of $20 =$ ☐ (78)

79. $\frac{2}{3}\%$ of $3000 =$ ☐ (79)

80. ☐ % of $24 = 8$.

81. ☐ % of $60 = 6$.

82. ☐ % of $20 = 25$.

83. $4 =$ ☐ % of 20.

84. $9 =$ ☐ % of 18.

85. $8 =$ ☐ % of 80.

Write these decimals as per cents:

86. $.355 =$ ☐ % (86)

87. $.123 =$ ☐ % (87)

88. $.1825 =$ ☐ % (88)

Rewrite the following decimals, arranging them in the order of their size, the largest first and the smallest last:

89. .93 .15 .94 ☐ (89)

90. .40 2.5 .875 ☐ (90)

Write these as decimal fractions; carry the answer to three places and round off to two places:

91. $\frac{7}{16} =$ ☐ (91)

92. $\frac{5}{16} =$ ☐ (92)

93. Mary bought an $8 dress at a 15% discount. What did she pay for the dress? ☐ (93)

94. What is the interest for a year on $175 at 6%? ☐ (94)

95. Mr. Brown found that $22\frac{1}{2}\%$ of his peaches were not good enough to sell. Out of 80 bushels he could sell ___?___ bushels. ☐ (95)

96. Carl earned $32 during his summer vacation. He spent $14\frac{1}{2}\%$ of this money for schoolbooks. How much did his books cost? ☐ (96)

97. What do you pay for goods marked $13.50 with a discount of 2%? ☐ (97)

98. What per cent of your investment do you make if you invest $125 and gain $5? ☐ % (98)

99. What is the interest for a year on $300 at $4\frac{1}{2}\%$? ☐ (99)

100. There are 2150 pupils in one junior high school of this city. The principal of this school expects an increase of 6% in the number of pupils next semester. How many pupils does he plan to have next semester? ☐ (100)

When you finish this part, go back and make sure that your work i correct.

Intermediate • GRADES 7 - 8 - 9 • form AA

California Arithmetic Test

(Formerly: Progressive Arithmetic Test)

DEVISED BY ERNEST W. TIEGS AND WILLIS W. CLARK

INSTRUCTIONS TO STUDENTS:

This is an arithmetic test. In taking it you will show how well you can think and work problems. No one is expected to do the whole test correctly, but you should answer as many items as you can. Work as fast as you can without making mistakes.

DO NOT WRITE OR MARK ON THIS TEST BOOKLET UNLESS TOLD TO DO SO BY THE EXAMINER.

LISHED BY CALIFORNIA TEST BUREAU — 5916 HOLLYWOOD BOULEVARD — LOS ANGELES 28, CALIFORNIA
NCH OFFICES: MADISON, WISC.; NEW CUMBERLAND, PA. — PRINTED IN U. S. A.
17 6 5 4 3

Do not write, mark, or figure on this test booklet unless told to do so by the examin

DIRECTIONS: Decide how each of the amounts below should be written as a number. Then mark as you are told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think that none of the answers given is correct, mark the letter, e. In doing this test you should finish the first column before doing the second. Look at the samples to the right and see how they are marked.

Sample A: Twelve

a 10
b 12
c 11
d 2
e None

Correct Answer Sheet Mark

	a	b	c	d
A		I		

Correct Test Booklet Mark: *b* A

Sample B: Twenty

a 22
b 200
c 2
d 21
e None

Correct Answer Sheet Mark

	a	b	c	d
B				

Correct Test Booklet Mark: *e* B

TEST 3 — SECTION A

1. Eight hundred forty-five
   a 80,045
   b 8045
   c 845
   d 458
   e None ____ (1)

2. Five thousand twenty
   a 520
   b 5020
   c 500020
   d 50,020
   e None ____ (2)

3. Ten thousand sixty-four
   a 10,000,64
   b 1064
   c 10,064
   d 10,640
   e None ____ (3)

4. One million ten thousand eleven
   a 1,001,011
   b 1,000,000,10,000,11
   c 1,010,011
   d 1,100,011
   e None ____ (4)

5. Three-eighths
   a .38
   b 888
   c .038
   d 8/3
   e None ____ (5)

6. Ninety-nine dollars and five cents
   a $99.5¢
   b $99.5
   c $99.05
   d 99.05
   e None ____ (6)

7. Fifty-five per cent
   a 55,100
   b $0.55
   c 55%
   d 55
   e None ____ (7)

✓ Read these Roman numerals. Then mark as have been told the letter of each correct ans

8. LXX means
   a 20
   b 30
   c 70
   d 90
   e None ____ (

9. DCC means
   a 200
   b 400
   c 600
   d 700
   e None ____ (

10. M means
    a 500
    b 1000
    c 4000
    d 6000
    e None ____ (

✓ Find the largest number, marked a, b, c, or d each of the following rows. Then mark its let

11. a 45 b 200 c 156 d 80 ____

12. a $89\frac{3}{4}$ b $66\frac{1}{2}$ c $106\frac{5}{6}$ d $55\frac{2}{3}$ ____

13. a .025 b .099 c .75 d .015 ____

14. a $\frac{5}{6}$ b $\frac{3}{4}$ c $\frac{7}{8}$ d $\frac{2}{3}$ ____

15. a $\frac{3}{4}$ b $(\frac{3}{4})^2$ c $(\frac{2}{3})^4$ d $(\frac{7}{8})^3$ ____

STOP NOW WAIT FOR FURTHER INSTRUCTION

Sec. A Score (number right) .....

DIRECTIONS: Mark the letter or number of each correct answer. If you do not know an answer, or you think that none of the answers given is correct, you should mark the letter, e (items 16-20), or the number, 5 (items 21-25). Finish the first column before doing the second. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

TEST 3 — SECTION B

16. $\sqrt{64}$ is	a 10 b 8 c 4096 d 24 e None	21. π means	1 add 2 pi 3 radius 4 degree 5 None
	(16)		(21)
17. 10% of 50 =	a 500 b 60 c 5 d $\frac{1}{5}$ e None	22. % means	1 per cent 2 subtract 3 dram 4 dollar 5 None
	(17)		(22)
18. A right angle equals how many degrees?	a 90° b 45° c 180° d 360° e None	23. ° means	1 multiply 2 degree 3 per cent 4 divide 5 None
	(18)		(23)
19. Which two numbers are both factors of 15?	a 10,5 b 3,5 c 2,25 d 2,30 e None	24. $\sqrt{}$ means	1 add 2 ounce 3 interest 4 square root 5 None
	(19)		(24)
20. What is the greatest common divisor of 9, 18, and 27?	a 27 b 6 c 3 d 9 e None	25. △ means	1 square 2 pyramid 3 circle 4 octagon 5 None
	(20)		(25)

DIRECTIONS: Some rules used in measurement, numbered 1, 2, 3, 4, and 5, are given to the right below. Some problems that can be worked with these rules are given on the left, numbered 26, 27, 28, 29, and 30. Mark the number of the rule on the right which is used to find the answer to each problem on the left.

Problems	Rule
26 Volume of a prism	____26
27 Area of a rectangle	____27
28 Length of a rectangle	____28
29 Circumference of a circle	____29
30 Area of a triangle	____30

Rules Used in Measurement

1. Multiply ½ base by altitude.
2. Multiply diameter by 3.1416 or $3\frac{1}{7}$.
3. Multiply width by length.
4. Divide area by width.
5. Multiply area of base by altitude.

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. B Score
(number right).....

DIRECTIONS: Work these problems. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think that none of the answers given is correct, you should mark the letter, e. Finish the first column before doing the second. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

TEST 3 — SECTION C

31. Add: $\begin{array}{r} 72 \\ -31 \\ \hline 28 \end{array}$

a 131
b 13
c 69
d 75
e None

(31)

32. Subtract: $\begin{array}{r} 45\,d \\ 28\,d \\ \hline \end{array}$

a 17
b 17 d
c 17 d^2
d —17 d
e None

(32)

33. The minuend is 8; the subtrahend is 12; the difference is

a —4
b 20
c 40
d ⅔
e None

(33)

34. Multiply: 4 (—8)

a —4
b 32
c —32
d —12
e None

(34)

35. Divide: $\frac{-24}{8}$

a —192
b 3
c 16
d —3
e None

(35)

✓ Find the value of x in each of these equation Then mark its letter.

36. $8x = 40$
$x =$

a 320
b 5
c ⅕
d 5x
e None

(36)

37. $x + 5 = 8$
$x =$

a 31
b 13
c 13x
d 12x
e None

(37)

38. $x^2 = 81$
$x =$

a x—9
b 81^2
c 9
d 81x
e None

(38)

39. $\frac{x}{2} = 8$
$x =$

a 8x
b 16
c 4
d ¼
e None

(39)

40. If $a = 4$, $b = 6$, and $c = 2$, find the value of x in the following equation:
$x = a + b - c$
$x =$

a 8
b 12
c 4
d 2
e None

(40)

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. C Score (number right).....

DIRECTIONS: Work these problems. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think none of the answers given is correct, you should mark the letter, e. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

TEST 3 — SECTION D

41. In a classroom there were 6 rows of desks with 7 desks in each row. Four desks were removed from the room. How many desks were left?

a 38
b 13
c 42
d 9
e None

(41)

42. Jack bought a used automobile for $75.00. He paid $15.00 down and is to pay the rest in twelve equal payments. How much will each payment be?

a $15.00
b $7.50
c $5.00
d $12.00
e None

(42)

43. Mary weighs 95 pounds, Sally weighs 85 pounds, and Jane weighs 120 pounds. What is their average weight in pounds?

a 100
b $96\frac{2}{3}$
c $97\frac{1}{2}$
d $102\frac{1}{2}$
e None

(43)

44. How many square feet are there in a strip of paper which is 2 feet wide and 22 feet long?

a 20
b 26
c 11
d 52
e None

(44)

45. A box is 10 inches long, 6 inches wide, and 4 inches deep. How many cubic inches does it contain?

a 20
b 120
c 64
d 240
e None

(45)

46. Find the area of a parallelogram having a base of 20 in. and an altitude of 8 in.

a 40 sq. in.
b 28 sq. in.
c $2\frac{1}{2}$ sq. in.
d 160 sq. in.
e None

(46)

47. Find the area of a triangle having a base of 20 in. and an altitude of 12 in.

a 240 sq. in.
b 120 sq. in.
c $1\frac{2}{3}$ sq. in.
d $\frac{3}{5}$ sq. in.
e None

(47)

GO RIGHT ON TO THE NEXT PAGE

48. When the scale of a map is "¼ in. = 20 mi.," how many miles apart are two cities that are represented on a map as 1½ in. apart?

a 30
b 60
c 40
d 120
e None

(48)

49. Dick, Harry, and James together received $50.00. Dick received $15.00, Harry received $25.00, and James received $10.00. What per cent of the $50.00 did Dick receive?

a 15
b 20
c 30
d 50
e None

(49)

50. Frank earned $16.00 and saved $8.00 of it. What per cent did he save?

a ½
b 50
c 33⅓
d 24.00
e None

(50)

51. A man received seven per cent interest on a loan of $200.00 for one year. How much interest did he receive?

a $20.00
b $14.00
c $7.00
d $9.00
e None

(51)

52. Helen missed 3 problems on a test but did 85% of them correctly. How many problems were there in the test?

a 20
b 10
c 82
d 88
e None

(52)

53. John sold brushes at $1.50 each and received a commission of 30% on his sales. How much did he make on each brush sold?

a $1.00
b 45¢
c 30¢
d 50¢
e None

(53)

54. A wooden building, valued at $12,500, was insured for 80% of its value. The rate of insurance was 24 cents per $100.00. What was the amount of the premium?

a $24.00
b $12.50
c $80.00
d $31.00
e None

(54)

55. Mary's father has a furniture store. The list price of a chair is $50.00 and two discounts are given: one of 20% and another of 10%. What did the chair cost Mary's father?

a $35.00
b $36.00
c $14.00
d $15.00
e None

(55)

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. D Score
(number right).....

DIRECTIONS: Do these problems in addition. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think none of the answers given is correct, you should mark the letter, e. Finish each column before going on to the next. Be sure to reduce fractions to lowest terms. Remember to do your figuring on scratch paper if you are marking your answers on an answer sheet.

TEST 4 — SECTION E

(56)
$$\begin{array}{r} 134 \\ +453 \end{array}$$
a 60702
b —681
c $3\frac{51}{134}$
d 687
e None

(57)
$$\begin{array}{r} 307 \\ +430 \end{array}$$
a —177
b 132010
c 737
d $1\frac{123}{307}$
e None

(58)
$$\begin{array}{r} 27 \\ +25 \end{array}$$
a 42
b 52
c 2
d $1\frac{2}{25}$
e None

(59)
$$\begin{array}{r} 25 \\ 42 \\ 33 \\ +72 \end{array}$$
a 172
b 162
c 182
d 171
e None

(60)
$$\begin{array}{r} 3271 \\ 9468 \\ 1345 \\ +\ 701 \end{array}$$
a 13675
b 14685
c 13775
d 14785
e None

(61)
$$\begin{array}{r} \$56.35 \\ 3.68 \\ 12.75 \\ +\ 8.15 \end{array}$$
a $60.94
b $79.73
c $80.93
d $69.88
e None

(62)
$\$0.00+\$.25+\$2+\$1.75=$
a $48.75
b $24.00
c $23.00
d $222
e None

(63)
$$\begin{array}{r} \frac{1}{4} \\ +\frac{1}{4} \end{array}$$
a 42
b $\frac{1}{16}$
c 0
d $\frac{1}{2}$
e None

(64)
$$\begin{array}{r} \frac{1}{4} \\ +\frac{1}{8} \end{array}$$
a $\frac{3}{8}$
b $\frac{2}{12}$
c $\frac{1}{6}$
d $\frac{1}{8}$
e None

(65)
$$\begin{array}{r} 12 \\ +\ 2\frac{3}{4} \end{array}$$
a $10\frac{1}{4}$
b $9\frac{1}{4}$
c $14\frac{3}{4}$
d $15\frac{3}{4}$
e None

(66)
$$\begin{array}{r} \frac{2}{3} \\ +2\frac{1}{6} \end{array}$$
a $-2\frac{1}{2}$
b $2\frac{5}{6}$
c $2\frac{3}{9}$
d $2\frac{1}{3}$
e None

(67)
$$\begin{array}{r} 12\frac{1}{4} \\ +\ 3\frac{1}{3} \end{array}$$
a $15\frac{7}{12}$
b $15\frac{2}{7}$
c $9\frac{1}{12}$
d $9\frac{1}{4}$
e None

(68)
$$\begin{array}{r} 3\frac{5}{6} \\ +2\frac{1}{4} \end{array}$$
a $5\frac{23}{20}$
b $1\frac{1}{2}$
c $6\frac{1}{12}$
d $5\frac{6}{10}$
e None

(69)
$$\begin{array}{r} 53\frac{1}{2} \\ 12\frac{2}{3} \\ +32\frac{3}{4} \end{array}$$
a $97\frac{7}{9}$
b $98\frac{11}{12}$
c $97\frac{23}{12}$
d $97\frac{6}{14}$
e None

(70)
$6\frac{1}{2}+6.5=$
a 13
b $12\frac{1}{2}$
c $12\frac{1}{2}.5$
d 12.5
e None

(71)
$.18\frac{1}{3}+12.15=$
a 30.475
b 6.775
c $12\frac{1}{3}$
d 6.475
e None

(72)
$.05+.164+.2108=$
a .08748
b .2277
c .2222
d .4248
e None

(73)
$33.4+6.21+.0382+8=$
a 47.6482
b 8.1337
c 1.2343
d 17.5882
e None

(74)
10% of 60+10% of 80=
a 48
b —2
c 14
d 2
e None

(75)
$$\begin{array}{r} 3\text{ yd. }2\text{ ft. }8\text{ in.} \\ +2\text{ yd. }1\text{ ft. }6\text{ in.} \end{array}$$
a 5 yd. 3 ft. 14 in.
b 1 yd. 1 ft. 2 in.
c 5 yd. 4 ft. 2 in.
d 6 yd. 1 ft. 2 in.
e None

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. E Score
(number right) .....

DIRECTIONS: Do these problems in subtraction. Then mark as you have been told the letter of each correct answer. For some of the problems none of the answers given may be correct. If you cannot work a problem, or if you think none of the answers given is correct you should mark the letter, e. Finish each column before going on to the next. Be sure to reduce fractions to lowest terms.

TEST 4 — SECTION F

(76)
$$\begin{array}{r} 387 \\ 252 \\ \hline \end{array}$$
a 135
b 639
c 125
d —97524
e None
(76) ____

(77)
$$\begin{array}{r} 458 \\ 106 \\ \hline \end{array}$$
a 564
b 352
c 302
d 664
e None
(77) ____

(78)
$$\begin{array}{r} 71 \\ 27 \\ \hline \end{array}$$
a 98
b —1917
c 58
d 54
e None
(78) ____

(79)
$$\begin{array}{r} 2460 \\ 1870 \\ \hline \end{array}$$
a —4330
b 4330
c 1410
d 590
e None
(79) ____

(80)
$$\begin{array}{r} 8507 \\ 2939 \\ \hline \end{array}$$
a 5568
b 9446
c 10436
d 6678
e None
(80) ____

(81)
$$\begin{array}{r} \$15.25 \\ 1.65 \\ \hline \end{array}$$
a $17.90
b $13.60
c $14.60
d $16.80
e None
(81) ____

(82) $200 — $14.25 =
a $214.25
b $5.75
c $185.75
d $20,014.25
e None
(82) ____

(83)
$$\begin{array}{r} 1/3 \\ 1/3 \\ \hline \end{array}$$
a 0
b 2/3
c 1/9
d —1/3
e None
(83) ____

(84)
$$\begin{array}{r} 2/5 \\ 1/5 \\ \hline \end{array}$$
a 3/5
b 1/5
c —1/5
d 3/25
e None
(84) ____

(85)
$$\begin{array}{r} 3/4 \\ 1/8 \\ \hline \end{array}$$
a 7/8
b 5/8
c —7/8
d —5/8
e None
(85) ____

(86)
$$\begin{array}{r} 4/5 \\ 1/4 \\ \hline \end{array}$$
a 1 1/20
b 1/4
c 11/20
d 3/5
e None
(86) ____

(87)
$$\begin{array}{r} 7\ 3/7 \\ 6 \\ \hline \end{array}$$
a 1 3/7
b 13 3/7
c —1 3/7
d —13 3/7
e None
(87) ____

(88)
$$\begin{array}{r} 8 \\ 4\ 1/4 \\ \hline \end{array}$$
a 3 3/4
b 12 1/4
c 32 1/4
d 2 1/4
e None
(88) ____

(89)
$$\begin{array}{r} 3\ 3\ 1/8 \\ 1\ 1\ 3/8 \\ \hline \end{array}$$
a 21 3/4
b 22 1/4
c 44 1/2
d —44 1/2
e None
(89) ____

(90) 30.6 — 5 1/2 =
a 31
b 25.1
c 25.5 1/2
d 36
e None
(90) ____

(91) 55 4/5 — 12.22 =
a 43.58
b 68.12
c 43.68
d —67.02
e None
(91) ____

(92) 86.350 — 24.15 =
a 83.935
b 62.2
c 110.50
d 88.765
e None
(92) ____

(93) 57.09 — 7.0435 =
a 64.1335
b —26.655
c 50.0465
d 54.1335
e None
(93) ____

(94) 1/5 of 20 — 1/4 of 12 =
a 1/3
b 3/4
c 1
d 12
e None
(94) ____

(95)
$$\begin{array}{r} 5 \text{ da. } 8 \text{ hr. } 30 \text{ min.} \\ 4 \text{ da. } 10 \text{ hr. } 40 \text{ min.} \\ \hline \end{array}$$
a 9 da. 19 hr. 70 min.
b 10 da. 7 hr. 10 min.
c 1 da. 11 hr. 50 min.
d 21 hr. 50 min.
e None
(95) ____

STOP NOW WAIT FOR FURTHER INSTRUCTIO

Sec. F Score
(number right) .....

DIRECTIONS: Do these problems in multiplication. Then mark as you have been told the letter of each correct answer. Finish each column before going on to the next. Be sure to reduce fractions to lowest terms.

TEST 4 — SECTION G

)

$$\begin{array}{r} 3\,2\,2 \\ \times\quad 6 \\ \hline \end{array}$$

a 1932
b 328
c 316
d 1822
e None

(96)

)

$$\begin{array}{r} 2\,0\,0 \\ \times\quad 5 \\ \hline \end{array}$$

a 205
b 1000
c 195
d 100
e None

(97)

)

$$\begin{array}{r} 7\,0\,6 \\ \times\quad 8 \\ \hline \end{array}$$

a 714
b 698
c 5648
d 5608
e None

(98)

)

$$\begin{array}{r} 4\,8\,6 \\ \times\quad 3\,2 \\ \hline \end{array}$$

a 518
b 454
c $15\frac{3}{16}$
d 15552
e None

(99)

))

$$\begin{array}{r} 9\,5\,6 \\ \times\quad 4\,0 \\ \hline \end{array}$$

a 38240
b 996
c 916
d 3824
e None

(100)

.)

$$\begin{array}{r} 5\,0\,0 \\ \times\quad 3\,0 \\ \hline \end{array}$$

a 530
b 15000
c 470
d $16\frac{2}{3}$
e None

(101)

1)

$$\begin{array}{r} 2\,0\,3\,6 \\ \times\quad 2\,0\,8 \\ \hline \end{array}$$

a 2244
b 1828
c 423488
d 56968
e None

(102)

(103)

$4 \times \frac{1}{4} =$

a 1
b $4\frac{1}{4}$
c $\frac{1}{6}$
d $3\frac{3}{4}$
e None

(103)

(104)

$\frac{1}{5} \times \frac{1}{5} =$

a $\frac{2}{5}$
b $\frac{1}{25}$
c $\frac{3}{10}$
d $\frac{1}{5}$
e None

(104)

(105)

$\frac{1}{4} \times \frac{4}{5} =$

a $\frac{3}{20}$
b $\frac{5}{9}$
c $\frac{1}{5}$
d 1
e None

(105)

(106)

$\frac{2}{3} \times \frac{6}{8} =$

a $-\frac{1}{12}$
b $1\frac{1}{24}$
c $\frac{8}{11}$
d $\frac{1}{2}$
e None

(106)

(107)

$8 \times 2\frac{1}{4} =$

a 18
b $10\frac{1}{4}$
c $16\frac{1}{4}$
d $5\frac{3}{4}$
e None

(107)

(108)

$8\frac{2}{3} \times \frac{2}{5} =$

a $5\frac{1}{15}$
b $3\frac{7}{15}$
c $7\frac{14}{15}$
d $2\frac{2}{5}$
e None

(108)

(109)

$6\frac{3}{4} \times 5\frac{1}{3} =$

a $11\frac{4}{7}$
b $30\frac{1}{4}$
c 36
d $30\frac{4}{12}$
e None

(109)

(110)

$$\begin{array}{r} 4\,7\,\frac{3}{4} \\ \times 1\,2 \\ \hline \end{array}$$

a $35\frac{3}{4}$
b $564\frac{37}{4}$
c $59\frac{3}{4}$
d 573
e None

(110)

(111)

$$\begin{array}{r} 3\,5.7\,5 \\ \times\quad 3\,\frac{1}{5} \\ \hline \end{array}$$

a 114.4
b $35.78\frac{1}{5}$
c $35.71\frac{4}{5}$
d 7.15
e None

(111)

(112)

$$\begin{array}{r} 3\,8\,2.6 \\ \times\quad 5 \\ \hline \end{array}$$

a 191.30
b 1913
c 383.1
d 382.1
e None

(112)

(113)

$$\begin{array}{r} 4\,3.2 \\ \times .0\,2\,5 \\ \hline \end{array}$$

a 40.7
b 45.7
c 1.08
d 43.225
e None

(113)

(114)

$5 \times 30\%$ of $30 =$

a 45
b 5
c 35
d 14
e None

(114)

(115)

2 yd. 5 ft. 6 in.
$\times$ 5

a 19 yd. 3 ft. 6 in.
b 19 yd. 6 in.
c 10 yd. 25 ft. 30 in.
d 18 yd. 2 ft. 30 in.
e None

(115)

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. G Score
(number right).....

DIRECTIONS: Do these problems in division. Then mark as you have been told the letter of each correct answer. Finish each column before going on to the next. Be sure to express remainders as fractions and reduce fractions to lowest terms.

TEST 4 — SECTION H

(116) $4\overline{)3\ 2}$

a 8
b 128
c 28
d 36
e None

(116)

(117) $6\overline{)6\ 0}$

a 66
b 360
c 54
d 10
e None

(117)

(118) $5\overline{)4\ 5\ 5}$

a 450
b 91
c 460
d 2275
e None

(118)

(119) $4\overline{)4\ 2\ 4}$

a 428
b 16
c 420
d 106
e None

(119)

(120) $22\overline{)8\ 9\ 3\ 2}$

a 8910
b 46
c 406
d 8954
e None

(120)

(121) $300\overline{)9\ 0\ 0\ 0}$

a 300
b 30
c 9300
d 8700
e None

(121)

(122) $46\overline{)3\ 4\ 7\ 6}$

a 3522
b 3430
c $75\frac{13}{23}$
d 159896
e None

(122)

(123) $1 \div \frac{1}{3} =$

a $1\frac{1}{3}$
b 3
c $\frac{2}{3}$
d $\frac{1}{3}$
e None

(123)

(124) $\frac{1}{2} \div 2 =$

a $1\frac{1}{2}$
b $2\frac{1}{2}$
c $\frac{1}{4}$
d 1
e None

(124)

(125) $6 \div \frac{4}{5} =$

a $6\frac{4}{5}$
b $7\frac{1}{2}$
c $5\frac{1}{4}$
d $4\frac{4}{5}$
e None

(125)

(126) $\frac{2}{3} \div \frac{2}{3} =$

a $\frac{4}{9}$
b $1\frac{1}{3}$
c 1
d 0
e None

(126)

(127) $\frac{5}{8} \div \frac{1}{4} =$

a $\frac{1}{2}$
b $2\frac{1}{2}$
c $\frac{5}{24}$
d $4\frac{4}{5}$
e None

(127)

(128) $5\frac{3}{8} \div \frac{3}{4} =$

a $7\frac{1}{6}$
b $2\frac{1}{2}$
c $\frac{160}{9}$
d $53\frac{1}{3}$
e None

(128)

(129) $5\frac{2}{3} \div 2\frac{1}{4} =$

a 13
b $3\frac{5}{12}$
c $7\frac{11}{12}$
d $2\frac{14}{27}$
e None

(129)

(130) $150 \div 1\frac{1}{2} =$

a $151\frac{1}{2}$
b $148\frac{1}{2}$
c 100
d 225
e None

(130)

(131) $3\overline{)9\ 2\frac{3}{4}}$

a $95\frac{3}{4}$
b $89\frac{3}{4}$
c $30\frac{133}{144}$
d $30\frac{11}{12}$
e None

(131)

(132) $.03\overline{)9}$

a 3
b .27
c 300
d .03
e None

(132)

(133) $3\overline{)7.0\ 2}$

a 10.02
b 2.34
c 4.02
d 21.06
e None

(133)

(134) $.03\overline{)\ .7\ 0\ 2}$

a .234
b 2.34
c 23.4
d 234.0
e None

(134)

(135) $\frac{1}{2}$ of $8 \div \frac{1}{3}$ of $6 =$

a 6
b 2
c —2
d 8
e None

(135)

STOP NOW WAIT FOR FURTHER INSTRUCTIONS

Sec. H Score
(number right).....

California Arithmetic Test
intermediate GRADES 7 - 8 - 9 form AA

DEVISED BY ERNEST W. TIEGS AND WILLIS W. CLARK

Name..... (Last / First / Middle) Occupation or Grade..... Sex M-F

School or Organization..... City..... Date of Test..... (Month / Day / Year)

Examiner..... (.....) Student's Age..... Date of Birth..... (Month / Day / Year)

See MANUAL for instructions.

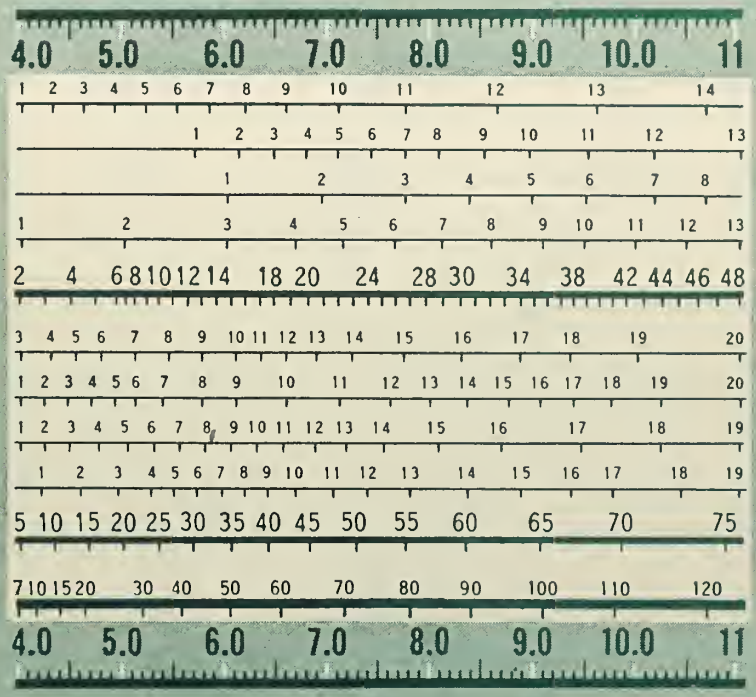
Test	Section	Possible Score	Student's Score
3. ARITHMETIC REASONING	A. Number Concept	15	
	B. Symbols and Rules	15	
	C. Numbers & Equations	10	
	D. Problems	15	
	TOTAL (A+B+C+D)	55	
4. ARITHMETIC FUNDAMENTALS	E. Addition	20	
	F. Subtraction	20	
	G. Multiplication	20	
	H. Division	20	
	TOTAL (E+F+G+H)	80	
	TOTAL ARITHMETIC	135	

Grade Placement

Percentile Rank

DIAGNOSTIC PROFILE (Chart Student's Scores Here)

Grade Placement



DIAGNOSTIC ANALYSIS OF LEARNING DIFFICULTIES

3. Arithmetic Reasoning

A. NUMBER CONCEPT:

- 1, 2, 3, 4, 5 — Writing numbers
- 6 — Writing money
- 7 — Writing per cent
- 8, 9, 10 — Roman numbers
- 11 — Whole numbers
- 12, 13, 14 — Fractions & decimals
- 15 — Exponents

B. SYMBOLS AND RULES:

- 16, 17, 21, 22, 23, 24, 25 — Symbols
- 18, 19, 20 — Vocabulary
- 26, 27, 28, 29, 30 — Rules

C. NUMBERS AND EQUATIONS:

- 31, 32, 33, 34, 35 — Negative numbers
- 36, 37, 38, 39, 40 — Solving equations

D. PROBLEMS:

- 41, 42, 43 — Two-step
- 42, 43 — Sharing & averaging
- 44, 45, 46, 47 — Sq. and Cu. measure
- 48 — Ratio
- 49, 50, 51, 52 — Percentage
- 53, 54, 55 — Commission and disc.

4. Arithmetic Fundamentals

E. ADDITION:

- 56, 57 — Simple combinations
- 58, 59, 60, 61 — Carrying
- 57, 60, 62 — Zeros
- 59, 60, 61 — Column addition
- 61, 62 — Adding money
- 63 — Adding numerators
- 64, 66, 67, 68, 69 — Common denom.
- 65, 66, 67, 68, 69 — Mixed numbers
- 70, 71 — Fractions & decimals
- 72, 73 — Writing decimals
- 74 — Adding percentages
- 75 — Denominate numbers

F. SUBTRACTION:

- 76, 77 — Simple combinations
- 78, 79, 80, 81, 82 — Borrowing
- 77, 79, 80 — Zeros
- 81, 82 — Subtracting money
- 83, 84 — Subtract. numerators
- 85, 86 — Common denom.
- 87 — Whole from mxd. nos
- 88, 89 — Borrowing, mixed nos.
- 90, 91 — Fractions & decimals
- 92, 93 — Writing decimals
- 94 — Fractional parts
- 95 — Denominate numbers

G. MULTIPLICATION:

- 96, 97, 98, 99, 100, 101, 102 — Tables
- 97, 98, 101 — Zeros in multiplicand
- 100, 101, 102 — Zeros in multiplier
- 99, 100, 101 — Two-place multipliers
- 103, 105, 106 — Cancellation, fractions
- 104 — Mult. num. & denom.
- 107, 108, 109, 110 — Mixed numbers
- 111 — Fractions & decimals
- 112, 113 — Pointing off decimals
- 114 — Per cent of number
- 115 — Denominate numbers

H. DIVISION:

- 116, 117, 118, 119, 120, 121, 122 — Tables
- 117, 119, 120, 121 — Zeros in quotient
- 122 — Remainders
- 123, 124, 125, 126, 127, 128, 129, 130 — Inverting divisors
- 128, 129, 130 — Mixed numbers